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THESIS

COMPOSITION OF MATERIAL PRICE INDICES
FOR OPERATION AND MAINTENANCE, NAVY
BUDGETARY ACCOUNT

by

Paul Richard Gorman

September 1976

Thesis Advisor: M.G. Sovereign

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(20. ABSTRACT Continued)

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Composition of Material Price Indices
for Operation and Maintenance, Navy
Budgetary Account

by

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ABSTRACT

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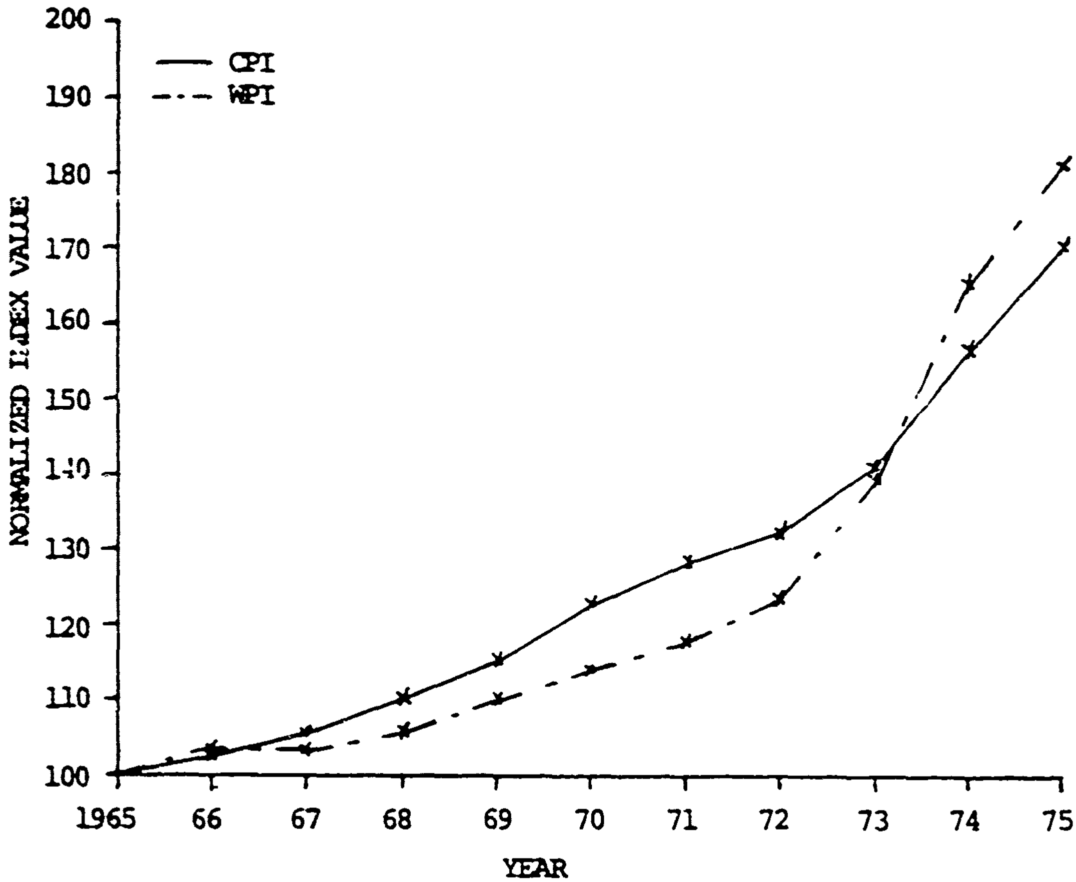
I. INTRODUCTION

It is the purpose of this thesis to develop an aggregate, operationally meaningful measure of inflation for those commodities which are accounted for within the Operation and Maintenance, Navy, budgetary account.

Inflation may be defined many ways, depending upon the context within which the word is used. One way, for the purpose of this thesis, is to define inflation as the general rise in prices across the entire economy. Two important measures of inflation are the Wholesale Price Index (WPI) and the Consumer Price Index (CPI). The WPI is a monthly measure of changes in price of commodities sold in large quantities in primary markets. Many of the commodities priced in the WPI are used in the production of items priced in the CPI. The CPI is a measure of changes in price of consumer goods and services purchased by urban wage-earners and clerical workers. In the past, service i ms (which are labor intensive) have increased faster in price than other items.

Since 1965, the United States has experienced a prolonged, almost uninterrupted, period of rising prices throughout its economy. The Wholesale Price Index for All Commodities (1967 = 100) moved from 95.2 in January 1965 to 179.4 in January 1976, an increase of 88.4 percent. During the same period, the Consumer Price Index moved from 93.6 to 166.7, an increase of 78.1 percent.

As Graph 1-1 shows, these two measures of inflation do not follow the same paths over time. A differential exists in the rates of increase of the two groups of commodities. Each index, though rising overall, is distinct in its characterization of the inflationary effects upon the prices of those commodities which it represents.



GRAPH 1-1

It is hoped that the indices developed within this thesis might be useful to the Congressional Budget Office.

The Congressional Budget Office (CBO) was established by the Congressional Budget and Impoundment Control Act of 1974. The Act initiated reform of the Congressional budgetary process. The CBO may best be described as the analytical arm of Congress for budgetary processes. It is responsible for the analysis of the President's budget and recommends alternatives to it. One requirement which is imposed upon the CBO is the Current Services Projection report.

The Current Services Projection estimates for five years the dollar costs of federal programs, such as defense, under the assumption that the current level of activity will be maintained for each program. One major problem in a projection of this type is the method of dealing with inflation. The current services concept, the methods, and the problems are further explained in the next sections of this chapter.

A. THE CONGRESSIONAL RESEARCH SERVICE'S MODEL FOR CURRENT SERVICES FIVE YEAR PROJECTIONS

1. Overview

The Congressional Budget Office used[1] a computer model written in the Survey language for its five year

[1]The CRS model is no longer used for the five year projections for obligations, although it is filed on the CBO computer. The methodology and concepts are applicable at the time of writing.

projections. The model attempted to project Federal obligations for existing programs and activities. The model used generalized formulae to estimate obligations of budgetary accounts by object classification, using generalized growth factor variables which are introduced below.

The computer model assumed a constant real level of activity within each federal department except for recent known changes which may allow growth in the level of the program. As one program within a department nears completion, another program is initiated to replace it. Each program is projected forward from its given level of expenditure, taking price and wage changes, population growth, and the already known (i.e. legislated) growth in the real level of program activity into account. These are the generalized growth factor variables, which, as will be discussed, are used in "rate of change" form.

Since there are approximately twelve hundred individual accounts within the fiscal year's budget, each account was disaggregated into a facsimile of object classifications, or "market baskets" (this concept is further defined in Chapter III). These are shown in Table 1-1 below. It was then the individual object classification which was projected. This allowed the obligations of an account to be related to economic or demographic data or adapted to determine the effects of legislative action more readily than if the account were not disaggregated.

Table 1-1

CBO Classification of Expenditures Within Budgetary Accounts

Civilian Compensation
Military Compensation
Personnel Benefits
Utilities (Includes Object Classifications of Transportation of People; Transportation of Things; Rent, Communications, and Utilities; Printing and Reproduction)
Other Services
Equipment
Lands and Structures
Interest
Investment and Loans
Grants, Subsidies, and Contributions
Insurance Claims
Consolidated Obligations

It should be noted that object classifications are extremely broad categorizations of commodities, and an object classification may comprise part of any budgetary account. For example, Supplies and Materials is an object class common to both the Department of Defense's account "Operation and Maintenance, Navy," and the Department of Health, Education, and Welfare's account "Education for the Handicapped." However, it is not clear that the Supplies and Materials used by the Navy are indeed the same Supplies and Materials used for the education of the handicapped. Nor is it clear that the relative importance within the object classification of a commodity such as fuel is the same for both departments accounts.

The model did not attempt to take into account future policy changes, new program plans, or legislation which was not yet enacted.

The concept of the model was to project known obligations. However, the Congressional Budget and Impoundment Control Act of 1974 requested the estimation of federal outlays. In the estimation of future outlays, the stream of expenditures for a particular program may vary over the five years. The CBO anticipates treating the outlays for programs in such a way as to approximate the stream of expenditures for existing contracts throughout the projected period for some programs.

2. Methods of Projection

The estimating of Federal obligations for the five year period at current levels of activity attempts to take into account the increases of personnel pay and other prices, any known changes in real benefits or program levels, and population growth. Thus, the growth in expenditures for each object class within each account is separated into component factors. These independent variables are called PRICE, REAL, and POPULATION, respectively. These will be referred to as budgetary variables in the subsequent discussion.

Depending upon the account, each of the above components of dollar growth in the account can be held constant, or defaulted such that there is no growth represented by that budgetary variable. Otherwise, the component is included within an equation for the account on the basis of expected annual rates of change for all projected years. For example, the Department of Defense obligations are only affected

by inflation, and not real or population growth. The growth rates are then applied to the base year estimate to give an out-year estimate. Computationally, this is written as:

$$197X \text{ Estimate} = 197(X-1) \text{ Estimate} \times (\text{PRICE } 197X + \text{POPULATION } 197X + \text{REAL } 197X + 1)$$

where 197(X-1) is the base year, and the other variables represent annual estimated rates of change as defined above.

More specifically, for price and wage changes, the model's documentation [Ref. 5] states:

> "In most cases price increase adjustments are made to maintain constant expenditures in real terms. If not adjusted for increasing prices, in effect, the programs are assumed to be declining in real terms.
>
> "In fact, one of the major reasons for adjusting other programs for price increases in a projection is to obtain a yardstick against which to measure administration proposals and Congressional action. Since programs are proposed and enacted in dollar terms, one way of obtaining a measure of changes in real program activity is to compare the amount requested or legislated with what any given program would have cost if the same level of previous activity were to be carried out in the coming fiscal years, fully adjusted for anticipated pay and price increases."

The population variable, which gives some measure for "work load increases" for a program is expressed in terms of a rate of change of the population. This assumes that the per capita benefit remains constant, but the total number of people changes. The model documentation states

that the values used are obtained from a regression analysis to establish, for example, the number of people receiving social security or other benefits, on a program by program basis. The annual change in the number of people is then expressed by the budgetary variable POPULATION.

Real increases in program levels, represented by the variable REAL, are not well defined in the model. One of the problems is that obligations of funds for some programs prior to their appropriation can occur because of Contract Authority. Contract Authority is a type of budget authority which permits obligations of funds prior to appropriation, but requires a subsequent appropriation in order to liquidate the obligations. Contract Authority is generally associated with construction programs. No accommodation for Contract Authority was made in the model.

Real activity changes are handled synonymously with "work load changes" in many cases, and the documentation indicates that growth in many programs should possibly be represented by the variable POPULATION. The concept, however, seems to be that the variable REAL should represent some expansion of a program, or the addition of new activities within a program. This might indicate an increase in per capita benefits as measured by obligations, for example.

The model is composed of a series of mini-programs which relate the budgetary independent variables to economic or demographic variables such as the Consumer Price Index,

in linear or log-linear form, by regression. Within the mini-program, a value is calculated for the then dependent budgetary variable, which is then used as an independent variable in the main program. The documentation does not indicate explicitly how these relations were obtained, except that, in the documentation for each object class, a statement of assumption is made. For example, for the object class Equipment, it is assumed that the price increase is at the same rate as the Implicit Price Deflator — Investment, Producers Durable Equipment.

According to the documentation, "The equation for each (budgetary) variable must apply to all accounts, no matter how diverse." Therefore, as shown in the example below, each budgetary variable has associated with it a large number of coefficients in the equation as multipliers of the economic or demographic variables. If the economic or demographic variable does not affect the budgetary variable, its coefficient is presumably zero.

As an example of the form which the algorithm takes on for each budgetary variable, and then for each object class, the projected estimate for year 197X for the object class Grants and Subsidies is as follows:

Price 1.76 = I11 + I12 x LGPXLAG.76 + I13 x LGCPILAG.76
+ I14 + LGPCNFB.76 + I15 x LGPCSH.76 + I16
x LGPIG1.76 + I17 x LGCP1.76 + I18 x
LGCP1C.76

POPULATION. 76 = I21 + I22 x LGRO.76 + I23 x LGROLAG.76

+ I24 x TIME.76 + I25 x GRFS.76

REAL.1 = I31 + I32 x ADDHA.76 + I33 x ADDEND.76 +

I34 x ADDOCOMP.76 + I35 x ADDCD.76

GRANTS AND SUBSIDIES.76 = GRANTS AND SUBSIDIES.75 x

(PRICE1.76 + POPULATION.76 + REAL.76

+ 1)

where Iij's are coefficients which may be zero;

LGPXLAG is the logarithm of the growth rate of the Price of Gross Product Deflator, lagged;

LGCPILAG is the logarithm of the growth rate of the Consumer Price Index, lagged;

LGPCNFB is the logarithm of the growth rate of the Consumer Price Index of Food and Beverages;

LGPCSH is the logarithm of the growth rate of Consumer Expenditure for Housing Index;

LGCP1 is the logarithm of the growth rate of the Consumer Price Index;

LGCP1C is the logarithm of the growth rate of the Consumer Price Index, calendar year;

LGPIG1 is the logarithm of the growth rate of the Consumer Price Index, fiscal year.

In summary, the model used generalized formulae for projecting budgetary accounts, each account being disaggregated into object classifications. The budgetary variables were growth factors for prices and wages, population, and known growth in a program. These budgetary variables were expressed as rates of change, and were taken from long term

economic forecasts of other variables, such as the Consumer Price Index.

The next chapter reviews the Navy's reporting system for expenses associated with the Operation and Maintenance, Navy (O&M,N) account.

II. THE NAVY REPORTING SYSTEM FOR OPERATION AND MAINTENANCE

A. THE O&M,N BUDGETARY ACCOUNT

Dollars included within the Operation and Maintenance, Navy appropriation account provide for expenses, or consumption of resources, as opposed to investments which are provided for in the procurement appropriations.

O&M,N dollars buy an extremely broad range of resources necessary for the day-to-day activities of the Navy. Examples of these resources include fuels (aircraft and ship POL as well as gasoline and other types of fuel and lubricants); food; transportation of both people and things; many types of small equipment such as pumps, switchgear, and compressors; office supplies necessary for administration; repair and maintenance services; and civil service personnel wages and benefits.

The basic breakdown by the Navy of this appropriation for budgetary purposes is by FYDP Program. The applicable programs are as follows: Strategic Forces; General Purpose Forces; Intelligence and Communications; Central Supply and Maintenance; Training, Medical, and other Personnel Activities; and Support of Other Nations. Each of these programs is, in part, funded by this account.

Another way of classifying the obligations of the O&M,N appropriation is by object classification. "Object classification" is a term used to identify broad categories

of items and services for which dollar resources are obligated. An object class identifies broadly what types of resources will be used, or what the dollar resources will be obligated for. Every budgetary appropriation is disaggregated into object classes.

An example of both program and object class breakdowns is given in Appendix A, where an example of the fiscal year budget for O&M,N is exhibited.

In this study, the effect of inflation upon personnel related obligations is not addressed. There are two reasons for this. First, personnel compensation and benefit changes are directly legislated by Congress. Thus, although the changes in compensation and benefits are a function of the inflation within the economy, the changes are initiated by political legislation. Secondly, the CBO expressed satisfaction with their model's handling of these changes.

Therefore, only the material portion of the O&M,N appropriation is addressed. The object classes were alligned to coincide with the groupings used by the CBO. These object classes, along with their appropriate groupings are shown in Table 2-1 below. Detailed definitions are given in Chapter III.

The groupings below account for approximately 80 percent of the obligations included within O&M,N. It should be noted that although personnel compensation and benefits are not explicitly addressed in this study, nevertheless

Table 2-1

Classes of Material Expenditures

Utilities	(Includes object classes Travel and Transportation of Persons; Transportation of Things; Rent, Communications, and Utilities; and Printing and Reproduction)
Equipment	
Supplies and Materials	
Other Services	

the object class Other Services does include to a large extent wages and benefits of civilians.

The next section of this chapter briefly reviews the Navy's reporting system for expenses associated with the O&M,N account. The flow of information is traced from the local activity to the Comptroller of the Navy.

B. THE NAVY REPORTING SYSTEM FOR OBLIGATIONS

The Navy reporting system is management oriented. The system's purpose is to provide effective resource management. As such, special attention is given to operating budgets and the subsequent obligations made for operating and maintaining activities. Project PRIME (Priority Management Effort), begun on 1 July 1968, is a part of the Resource Management System (RMS) instituted specifically for the more efficient management of resources by operating activities [Ref. 6].

Within this system, several reports are made to the Naval Comptroller, originating at the local activity level.

The data, as it flows from the local activity level, is combined with similar data from other activities. This pyramiding of data necessarily causes substantial loss of detail.

One required report which is initiated at the local activity level is the Functional Category/Expense Element Report (Nav Compt Form 2171). This report is generated monthly. Data for the report comes from the activity's job order accounting system or "any other locally designed method of organizing source documents." The purpose of the report is to "provide input for cost information systems at the Departmental level."[2]

Functional Categories, one breakdown by which Nav Compt Form 2171 allocates obligations, are used within the Planning, Programming, and Budgeting System (PPBS) in order to define why resources are being consumed. Functional Categories are the first subordinate classification below the FYDP program element. These are shown in Table 2-2.

Expense elements, also a classification of obligations on Nav Compt Form 2171, identify the kinds of resources being used. They are what the obligation or outlay was made for. Expense Elements are also shown in Table 2-2. Department of Defense Instruction 7220.20 defines each

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[2]Reference 6, P. 202.

Table 2-2

Naval Classification of Obligations

Functional Categories[3]	Elements of Expense[4]
1. Mission Operations	1. Military Personnel
2. Administration	2. Military Trainees
3. Supply Operations	3. Military Unassigned
4. Maintenance of Material	4. Civilian Personnel
5. Property Disposal	5. Travel of Personnel
6. Medical Operations	6. Transportation of Things
7. Overseas Dependent Education	7. Utilities and Rents
8. Base Services	8. Communications
9. Maintenance of Real Property	9. Purchased Equipment Maintenance (Inra-DOD)
10. Utility Operations	10. Purchased Equipment Maintenance (Commercial)
11. Other Engineering Support	11. Printing and Reproduction
12. Minor Construction	12. Other Purchased Services
13. Personnel Support	13. Aircraft POL
	14. Ship POL
	15. Other Supplies
	16. Equipment
	17. Other Expenses
	18. Service Credits

---

[3] Reference 6, P. 189.

[4] Reference 10, Pp. 10,11.

element of expense. Many are defined exactly as the object classification, which by reference to Appendix A, their names would imply. Others, however, such as Ship POL or Aircraft POL are more narrowly defined than an object class, but can be included within an object classification, such as Supplies and Materials in the case of POL.

At the local level, Functional Category/Expense Elements are recorded for control and budgetary purposes on a form such as CNET Form 7130/1 shown in Appendix A.

Input data to Nav Compt Form 2171 is originated at a cost center, such as a department or office, at the local activity level. Here, a requisition form (job order) is initiated for the purchase of an item or service. This form contains information with regard to Element of Expense, etc. The form flows to the activity comptroller, and then on to the accounting activity.

For example, a requisition initiated at a department of the Naval Postgraduate School, is forewarded to the NPGS comptroller office. The information is then forwarded to the Naval Supply Center, Oakland, the accounting activity for the Naval Postgraduate School.

At the accounting activity, the information is computerized. Nav Compt Form 2171 is thus generated from the requisition information, and is computerized output. Nav Compt Form 2171 is then transmitted to the next higher command or bureau, called the Functional Commander. (In the case of the Naval Postgraduate School, the report is

transmitted to the Chief of Naval Education and Training (CNET)). This authority then consolidates all of its inputs and forwards a report to its reporting senior, generally the CNO Budget Office. Ultimately, a report is filed with the Comptroller of the Navy. The reporting flow is illustrated in Diagram 2-1.

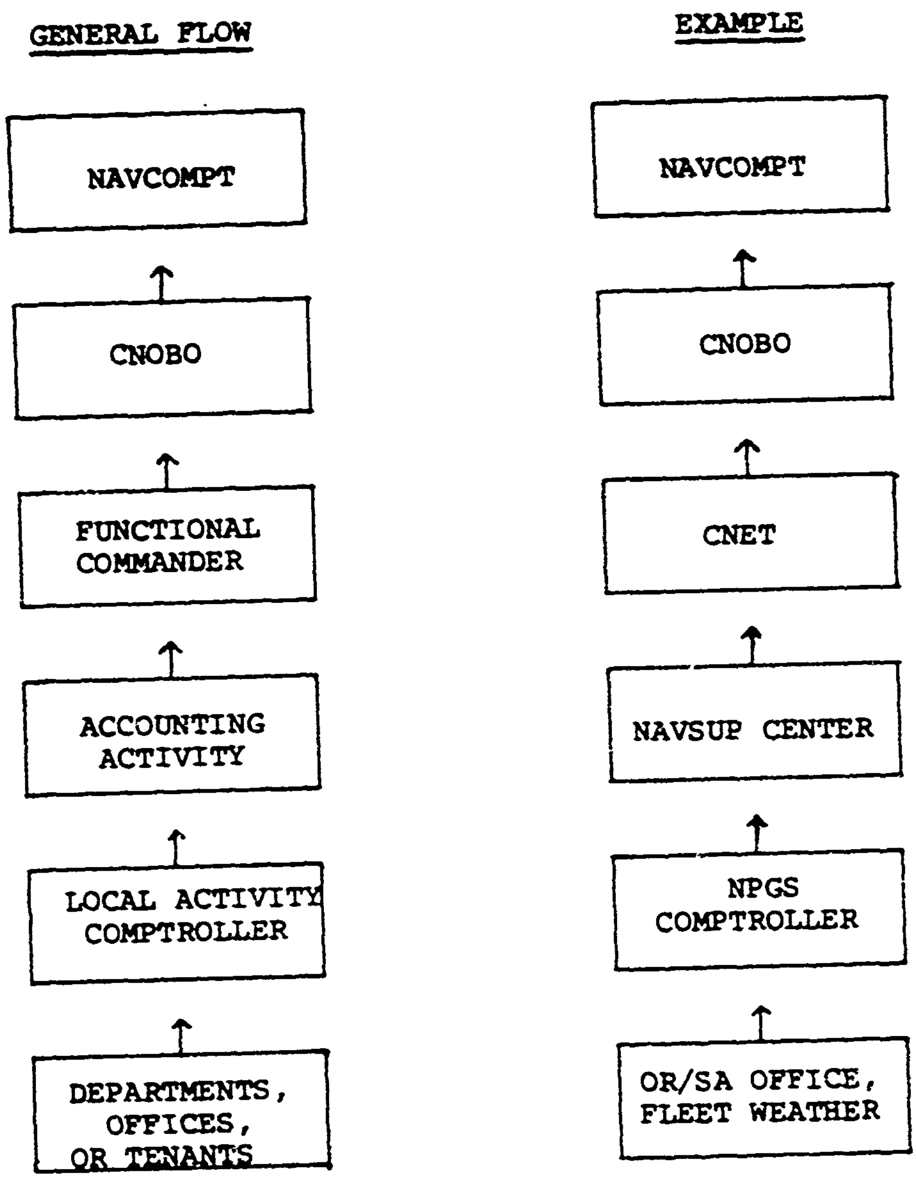
The result of the pyramiding of data is necessarily the loss of detail. Each local organization is considered by the Navy to be a unique entity. Decisions above the local level are made in terms of FYDP programs and functions, and seldom in terms of elements of expense. Therefore, for effective control of dollar resources, the specific items which are purchased receive little or no attention above the local level, but the funds themselves are strictly observed and controlled. This means that the specific goods and services for which obligations are incurred are known only at the cost centers of Naval activities.

One report which is specifically by object classes is made by higher commands, bureaus, and agencies to the Comptroller of the Navy. This report is called the Percentage Report on Obligations (Nav Compt Form 225A), and is included in Appendix A.

The 225A is an estimate in most cases, and according to NAVCOMPTINST 7301.20C of 21 August 1974, "actual object class obligations across all affected accounts is not currently available." The Percentage Report on Obligations by Object Class is made quarterly.

Diagram 2-1

Reporting Flow of O&M,N Obligations



The implications of the reporting procedures and documents used is that there exists little firm data above the local activity and cost center level from which a price index can be composed. Dollar values of obligations are known, but only for the broad categories called Elements of Expense. The specific goods or services for which dollar resources were obligated are very difficult to find, and are only recorded as, for example, Equipment, rather than a specific type of equipment.

Thus, in order to construct a specific index for operations and maintenance from raw data, one must access the records of many cost centers within even a single operating activity. However, this could prove valuable for an activity for budgeting purposes since, at present, the effects of inflation upon future obligations at the local level are not estimated. For budgeting purposes, each local activity is inclined to incorporate into their budget estimates an arbitrary factor for inflation. If an appropriate index and its projected values were made available to an operating activity, one could expect improved budget estimates.

The next chapter discusses the development of such an index, as it applies to this study.

III. DEVELOPMENT OF THE INDICES

A. THE NATURE OF THE PRICE INDEX USED

The construction of a composite price index is dependent upon the question which the index is expected to address. In this thesis, the question addressed is, "Given a budget constraint in some base year, o, what budget constraint is necessary in order to allow the same market basket of goods and services to be obtained in year j as was obtained in year o?" Therefore, the index formulation which was chosen to obtain an approximation to the "true" change in price levels was the Laspeyre Index.

The Laspeyre Index is formulated as:

$$I_{oj} = 100 \frac{\sum_i p_{ji} q_{oi}}{\sum_i p_{oi} q_{oi}}$$

where:

p_{ji} is the price of the i^{th} good or service in year j;

p_{oi} is the price of the i^{th} good or service in year o;

q_{oi} is the quantity of the i^{th} good or service purchased in year o.

Note that $\Sigma p_{oi} q_{oi}$ is the total "market value" of a combination of goods and services purchased in year o.

Also, q_{oi} may be written as q_{ai}, where this quantity represents an amount of the i^{th} item which was purchased in an arbitrary year a. This q_{ai} may be interpreted as some average quantity which was purchased in the given year. The important thing is that the quantity measure the item's relative importance within the market basket, and the year that the item was purchased is therefore irrelevant.

One may re-write the Laspeyre Index in an algebraic equivalent:

$$I_{oj} = 100 \frac{\sum_i \frac{p_{ji}}{p_{oi}} p_{oi} q_{ai}}{\sum_i p_{oi} q_{ai}} .$$

This formulation is more operationally useful because it is no longer necessary to multiply the price for an item each year by its quantity. Rather, it is now possible to concentrate on only the ratio of prices given in the two years. The ratio of prices, called the "price relative" of the i^{th} good multiplied by 100 will be denoted r_i. In symbols:

$$r_i = 100 \frac{p_{ji}}{p_{oi}} .$$

The index may now be expressed:

$$I_{oj} = \frac{\sum_i r_i p_{oi} q_{ai}}{\sum_i p_{oi} q_{ai}} ;$$

or written in longer notation:

$$I_{oj} = \frac{r_1 p_{o1} q_{ai}}{\sum_i p_{oi} q_{ai}} + \frac{r_2 p_{o2} q_{a2}}{\sum_i p_{oi} q_{ai}} + \ldots + \frac{r_i p_{oi} q_{ai}}{\sum_i p_{oi} q_{ai}} .$$

Note that $\frac{p_{oi} q_{ai}}{\sum_i p_{oi} q_{ai}}$ is the ratio of the market value of the i^{th} item to the market value of the entire market basket of goods and services. Therefore, this ratio may be taken to represent the relative value of the i^{th} good or service within the market basket. This relative value will be called the "weight", w_i, of the i^{th} item in the formulation.

Now the Lapeyre Index may be written as a sum of products of price relatives with weights, or:

$$I_{oj} = \sum_i r_i w_i .$$

The purpose of this derivation is to show that the direct use of quantities, q_{ai}, need not be made in order to form a useful index. It is necessary only to know the relative importance of the i^{th} item to the obligated "market basket" value, and two prices, one for the base year and one for the year in question.

The next section discusses the data used for this study.

B. THE DATA

In order to know the price behavior of some market basket of goods and services, the ideal approach would be

to know the exact composition of that market basket, and thus the relative importance of each item or group of items. Further, it would then be necessary to conduct periodic sampling of prices of the individual items, or cross sectional statistical sampling of the groups of items within the market basket. In this way one may construct an index with which to gauge the price behavior of the specific group of goods and services in which he is interested.

For a large number of items, however, it may not be particularly desirable, or feasible, to construct such an index. Considerable resources must be devoted to specifying the exact nature of the items to be sampled. Further resources must be devoted to the sampling of prices, either item by item or cross-sectionally. Once this data is collected, it must be stored, and used for the computations.

It was initially believed that such an index could be constructed which was specifically representative of the O&M,N account, using the procedures outlined above. It was thought that data must be compiled and stored in an accessable way somewhere in the Navy accounting system. At the minimum then, one could observe the specific items and the amounts thereof which were purchased annually, appropriately group the items, and thus arrive at a good approximation to the relative importance of each group of goods or services within an object class.

By observing the behavior of the prices of these groups over a period of several years, from data also stored in the data files, it would then be straight forward to compose an index which truely represented each object class and thus the complete O&M,N account.

However, as shown in Chapter II, no such centralized data file exists. Therefore, the level of detail desirable for constructing an object class index specific to an account is simply not currently available above the local level.

Nevertheless, the annual fiscal budget does publish obligations by object class. Because of the reporting procedures (NavCompt Form 225), these figures are believed to be reasonably reliable in the sense that they do represent estimates of the dollar amount of obligations for the object class.

In this study, it thus became necessary to use that data published in the fiscal budget for the object classifications. As previously noted, object classifications are extremely broad categories of commodities, and it was necessary to disaggregate the object classifications as much as possible. Through disaggregation, more narrow categories of commodities could be defined. Then commonly available, published indices could be chosen to represent, in effect, the price relatives of the categories.

The disaggregation of the object classifications into subcategories was based upon that reported in Ref. 11. The

disaggregation was done in a detailed study by the Research Analysis Corporation's Economic Impact Staff. Within that study, detailed data was available only for calendar year 1963, but the percent distributions of each of the more narrow categories was found. The RAC study was able to categorize and define the relative importance of the categories in terms of obligated dollars, and therefore obtain a percent distribution for about seventy-five percent of the account.

The next section discusses the methods and problems in the selection of proxy indices and weights for the composition of composite price indices.

C. THE SELECTION OF PROXY INDICES AND WEIGHTS

There are two distinct approaches to the selection of surrogate indices. If one knows the detailed composition of the groups of goods and services, as well as their price movements, then one can construct his own index based upon the available data, as previously discussed. If for some reason the data is no longer available, or if it is not deemed desirable to maintain the index because of resource availability, for example, then it may be necessary to find a proxy index for use.

In this case, one may use the original index in choosing the surrogate. He simply needs to search out another from such sources as the Bureau of Labor Statistics' Wholesale Price Indices or Consumer Price Indices which graphically

tracks closely and bears a logical relationship in composition to the original index. The next section will further discuss the statistical comparison of indices and the criteria used in this thesis.

The second approach to the selection of surrogate indices is on the basis of the index's name. This is a commonly used method in which the name of the published index is compared with the name of the item or the group of items for which one wishes to find a proxy. A pitfall exists here in that the proxy index may bot be representative of the items at all.

For example, the Wholesale Price Index General Purpose Machinery and Equipment, 11-4, might be used to represent the object class Equipment. The major components of this index, along with their weights in the WPI are shown in Table 3-1.

For comparison purposes, the CBO model used the Implicit Price Deflator — Investment, Producers Durable Equipment as their proxy for the object class Equipment. This index represents "all types of machinery, transportation equipment (automobiles, trucks, etc.), furniture and fixtures, engines and turbines, instruments, and other equipment."[5]

Although both indices represent types of equipment, clearly they represent different definitions of equipment.

[5] Survey of Current Business, P. 109, October 1969.

Table 3-1

Composition of General Purpose Machinery and Equipment[6]

BLS CODE	COMPOSITION	WPI WEIGHT
1141	Pumps, compressors, and equipment pumps such as reciprocating pumps, air compressors, gas compressors	0.200
1142	Elevators and escalators	0.066
1143	Fluid power equipment such as fluid power pumps, cylinders, fluid power hose and tube fittings	0.112
1144	Industrial material handling equipment such as conveying equipment, material handling trucks, hoists, and cranes	0.301
1145	Mechanical power transmission equipment	0.228
1146	Scales and balances	0.024
1147	Fans and blowers, except portable, such as centrifugal blower, propeller fan, attic fan	0.097
1148	Miscellaneous general purpose equipment such as valves and fittings, ball and roller bearings, plane bearings	0.669

Source: "Wholesale Prices and Price Indexes Supplement 1975, Data for 1974;" U.S. Department of Labor, Bureau of Labor Statistics.

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[6]The weight figures are percentages of the total WPI which represents the value of commodities in the index plus the imputed value of unpriced commodities assumed to have price movements similar to those of the priced items.

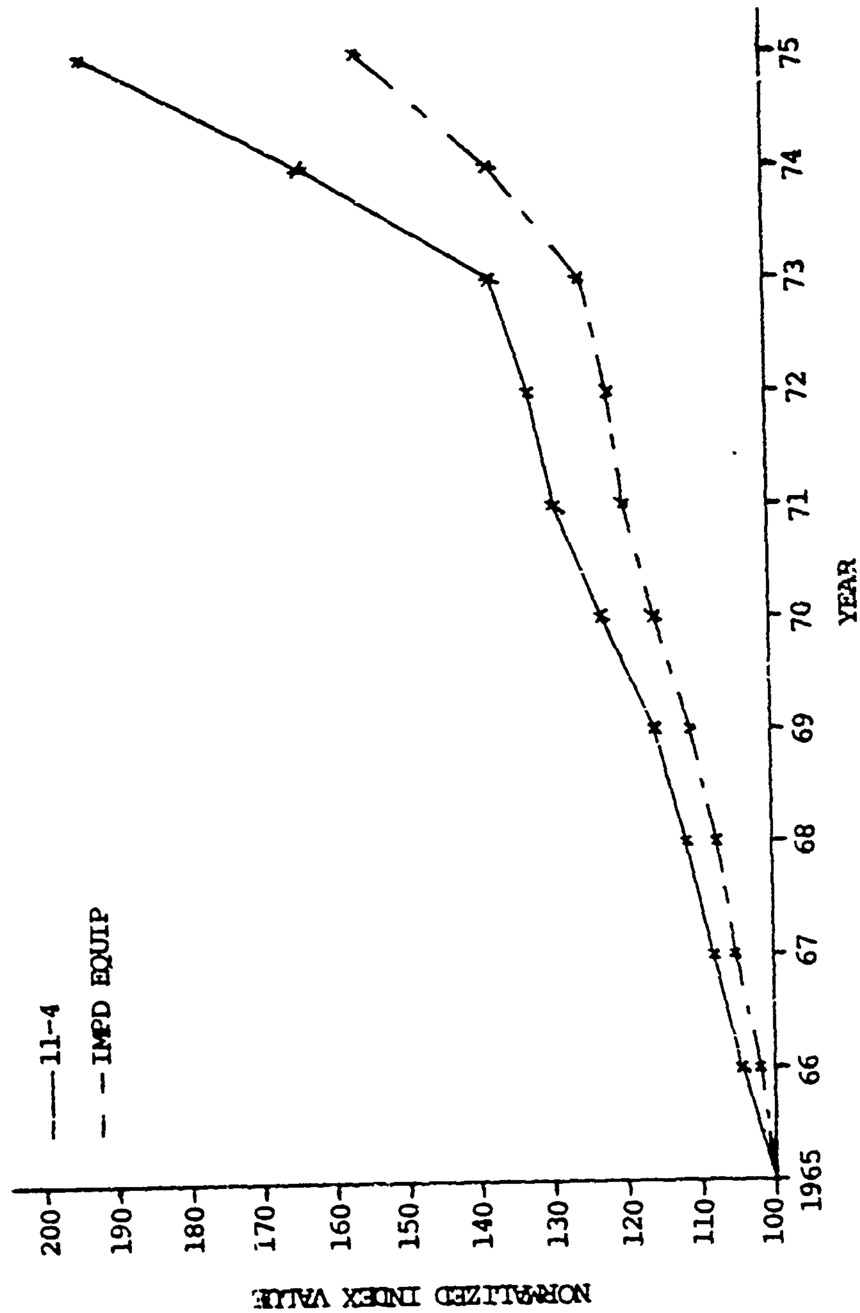
Producers Durable Equipment includes many more types of equipment than does WPI 11-4, and is much more representative of items accounted for in the object class, according to its definition. However, 11-4 would appear to represent a subset of goods represented by Producers Durable Equipment and therefore the indices may move approximately the same.

As shown in Graph 3-1 however, the two indices diverge rather markedly. From 1965 to 1973, the rates of change of the two are clearly not the same. The rate of growth of WPI 11-4 is about 4 percent per year for this period while the rate of growth of Producers Durable Equipment averages about 2.8 percent per annum. From 1973 to 1975, the growth rates are even more different, with WPI 11-4 growing at a rate of about 18.5 percent per annum and Producers Durable Equipment growing at about 11.5 percent per year.

This example illustrates that one must be careful when choosing a proxy index based upon the name of the index. Even though the names may be the same, or similar, there is no guarantee that the surrogate is a representative one.

This example further illustrates that, because of the large number of goods and services which may be accounted for by a particular object class, it is also necessary to find, or compose, an index which represents as many of the items as possible.

The relative importance, or weight, of a category of goods and services must also be carefully chosen in the



11-4
IMPD EQUIP
NORMALIZED INDEX VALUE
200
190
180
170
160
150
140
130
120
110
100
1965
66
67
68
69
70
71
72
73
74
75
YEAR

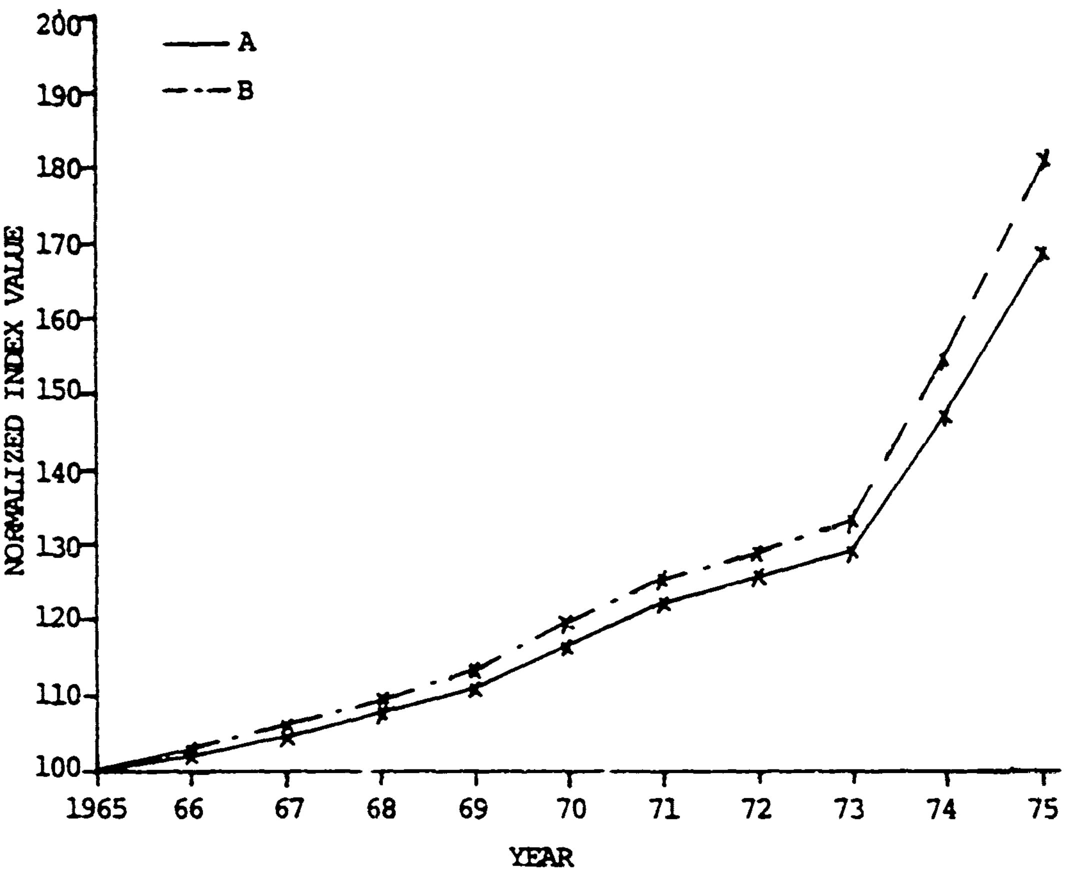
GRAPH 3-1

construction of a composite index. As an illustration, suppose some category of commodities can be represented by the WPI indices General Purpose Machinery, 11-4, and Motor Vehicles and Equipment, 14-1. The relative importance of each of the two subcategories will affect the behavior of the composite index over time. For example, if the two sets of weights given in Table 3-2 are applied in the construction of the composite index, the resultant indices are somewhat different, as shown in Graph 3-2. The average annual rate of increase of Index A from 1965 to 1973 is 3.2 percent while that of index B is about 4 percent per annum. However, during the two years 1974 and 1975, the annual average rates of increase were about 14.6 percent for index A and 16.6 percent for index B. In the first case, an annual average growth rate differential exists of only about 0.8 percent, but over a relatively long period of time. In the second case, a 2 percent differential exists over a much shorter period of time, and in an extremely high inflationary period.

Table 3-2

Compared Indices

WHOLESALE PRICE INDEX ELEMENTS	WEIGHTS FOR THE COMPOSITE INDICES A	B
11-4 General Purpose Machinery	.5	.75
14-1 Motor Vehicles and Equipment	.5	.25


A
B
200
190
180
170
160
150
140
130
120
110
100
NORMALIZED INDEX VALUE
1965
66
67
68
69
70
71
72
73
74
75
YEAR

GRAPH 3-2

It should be further noted that the sensitivity of the composite index to the weights is dependent upon the component indices. If the component indices track quite differently over the period, the effect of the weight sensitivity is magnified in the resulting composite index.

D. METHODOLOGY AND ASSUMPTIONS

In the computation of the indices for each object classification, it was assumed that the price paid by the government for each good or service purchased changed at the same rate as that price paid by private industry or the consumer. While it is not clear that changes in prices occur at the same rates for both the government and private sector, most of the goods and services purchased through the O&M,N account are used for the day to day activities related to operation and maintenance. Examples are fuels, vehicles, office supplies, electricity, etc. As such, these goods and services, except for possibly stricter government specifications for items even as trivial as government pens, have counterparts commonly available on the private market. Therefore, even though the absolute prices which the government pays for these goods and services may differ from those paid by private industry because of volume purchases or strict specifications, the relative changes in prices should be comparable.

Therefore, for each subgroup of goods or services within an object class, an index was chosen from commonly available

sources such as the Wholesale Price Indexes or the Consumer Price Indices to serve as a proxy. Although considerable judgment is required in the choice of a proxy index, and there are pitfalls, this choice was made through a comparison of the types of products represented by the index with the types of products within the subgroup. Where an obvious surrogate does not exist for the product, as in the case of Books and Maps, then an index was chosen which represents the price changes for one or more components of the subgroup, in this case Paper. In one case (Ordnance and Accessories), an index was built to represent the subgroup from other indices which represented inputs to the subgroup.

As was previously noted, the weights for each subgroup were based upon those found in the RAC study. As shown in Table 3-3, the relative importance of each object class within the O&M,N account differs from that found in the RAC study. Most of this difference, however, would appear to be within the object class Other Services, although the relative importance of each object class within the account varies from year to year.

Obligation of funds patterns have changed from year to year within the O&M,N account as shown in Table 3-3. Therefore, the relative importance, or weight, of each object classification has shifted. In order to develop an index which might be representative of the account as a whole, 1975 was chosen as the year in which the representative

Table 3-3

Object Classes as Percentage of Adjusted O&M,N Account

YEAR	EQUIPMENT	UTILITIES	SUPPLIES AND MATERIALS	OTHER SERVICES
1965	1.58%	12.23%	32.46%	53.74%
1966	2.16	13.10	27.29	57.42
1967	1.70	15.45	27.52	55.32
1968	1.84	15.70	24.91	57.54
1969	1.28	14.87	24.70	59.16
1970	0.89	14.69	22.58	63.56
1971	0.82	13.04	23.78	60.63
1972	0.75	13.39	21.75	64.08
1973	0.79	13.94	19.49	65.78
1974	0.62	11.30	18.36	69.72
1975	0.30	11.64	23.29	64.77
Arithmetic Average:				
	1.19%	13.59%	24.19%	61.02%
RAC Weights:				
	0.60%	23.10%	25.80%	27.70%

Unallocated Obligations: 23.8%

Source: RAC weights from Reference 11. Other weights were computed from data presented in Reference 3, adjusting the account to exclude explicit civilian pay and benefits.

market basket was purchased, or funds obligated. Thus, although the relative importance of each subgroup which composed the object class did not change, as based on 1963 weights, in the aggregate, the object class weights were changed. This implicitly re-defines the relative importance of each subgroup as related to the account as a whole.

A composite index for each object class was subsequently constructed assuming that the relative importance of each subgroup within the object class did not change from that of 1963. The composite index was then adjusted, or re-scaled, to the base year 1965. These operations are represented mathematically as:

$$I_{65,j} = r_i w_i$$

$$I_{65,j} = I_{65,j} \times 1/I_{65,65} \times 100$$

where $j = 1965, 1966, \ldots, 1975$.

Two problems are inherent in this procedure. One, the RAC study was unable to account for, or classify 23.8 percent of the obligated funds within the account. As may be noted from Table 3-3, the average percentages of each object class differ from the RAC percentages. This is to be expected, to some extent. However, it appears that a large portion of the unaccounted for funds would fall within the object class Other Services.

The second problem is that the change in the relative importance of each subgroup within an object class could not be measured, although some evidence exists to indicate that a shift has occurred. This is shown by the large proportion of funds obligated for fuels in 1975. Although Fuels accounted for 69% of the object class Supplies and Materials in 1963, or 17.8% of O&M,N, recent figures indicate that Fuels accounted for approximately 55% of the object class in 1975 and 12.9% of the O&M,N obligations, This data is shown in Table 3-4. Since the price of fuel has risen in recent years at a high rate, re-weighting this subgroup to 12.9% may tend to bias the index downward. In order to be conservative in the estimation of the Supplies and Materials index, the subgroup Fuels was re-weighted to 12.9%.

Table 3-4

Obligations of Funds for Fuels in the O&M,N Account for 1975

TYPE FUEL	DOLLARS OBLIGATED	BARRELS
Aircraft	$329,369,000	21,751,000
Ship	$352,241,000	23,908,000
Vehicle	$ 8,213,000	507,000
Other	$ 68,446,000	5,081,000
Total	$758,269,000	51,247,000

Source: Office of the Naval Comptroller, Washington, D.C.

Once the indices were computed, they were then compared with those used by the CBO. This comparison necessitated the establishment of some criterion for equivalence.

There are two general characteristics of the indices upon which to base a comparison. First, the two indices should be representative of the same general group of commodities. That is, the two indices must bear some logical relationship. Secondly, since indices may be normalized to a given base period, the rate of increase of the index over the period becomes important in the comparison, rather than the absolute value of the index. Thus it is the rates of increase of the two indices which must be compared.

In order to establish that the rates of increase of the indices were similar, two basic functional forms were specified for the data. The first form specified the value of the index as a function of time. The second specified one index as a function of another. In general, these two forms are:

$$\text{INDEX} = f(\text{TIME})$$

$$\text{INDEX 1} = f(\text{INDEX 2}) \; .$$

Those mathematical models used are given in Table 3-5. The parameters were estimated by linear regression techniques. Further discussion of the models as well as the

Table 3-5

Models for Comparison of Indices

MODEL	STATISTICAL HYPOTHESIS
1. Index $1_t = a + b \times \text{Index } 2_t + \text{error}_t$	$b = 1$
2. Index $1_t = b \times \text{Index } 2_t + \text{error}_t$	$b = 1$

Note: To force this line through the point (100,100), the equivalent model is: Index $1_t = 100(1 - b) + b \times \text{Index } 2_t + \text{error}_t$.

3. $\text{Index}_t = \exp(a + b_i \times \text{Time}_t + \text{error}_t)$	$b_1 = b_2$
4. $\text{Index}_t = 100 \exp(b_i \times \text{Time}_t + \text{error}_t)$	$b_1 = b_2$

where: $t = 1,2,\ldots,$ number of data points
$i = 1,2$

appropriate statistical tests for the comparison of the indices may be found in Appendix B.

The next chapter presents those indices computed, and the comparison of the indices with those used by the CBO.

IV. THE INDICES AND THEIR COMPARISON WITH THOSE USED BY THE CBO

In this chapter annual average indices for the period 1965-1975 are presented for each of the four object classifications. The weights and proxy indices used to calculate the indices are shown. Then the behavior of each index is compared with that proxy index used by the CBO, and, where possible, another index which is logically related to the composite index. The tracks of the indices over this period were described by linear regression, and hypothesis tests conducted in order to help determine the statistical equivalence of the indices. The results of the regressions and hypothesis tests are presented in Appendix B.

The calculated indices are given in Table 4-1, along with those indices used by the CBO and other possible proxy indices for each object class.

A. EQUIPMENT

This object class is defined as "personal property of a more or less durable nature – that is, which may be expected to have a period of service of a year or more after put into use without material impairment of its physical condition. It includes charges for services in connection with initial installation of equipment when performed under contract. It excludes commodities which are converted in the process of construction or manufacture,

Table 4-1

Possible Indices Applicable to the O&M,N Account[1]

CALCULATED INDEX				
OBJECT CLASS:	Equipment	Utilities	Supplies and Materials	Other Services
INDEX NAME:	Equipment	Utilities	Supplies and Materials	Other Services
YEAR				
1965	100.0	100.0	100.0	100.0
1966	102.2	101.2	103.6	102.3
1967	105.0	102.4	105.7	105.8
1968	107.8	103.6	105.2	111.5
1969	110.6	108.3(100.0)	107.8	117.1
1970	115.3	115.5(106.9)	110.3	124.4
1971	120.1	122.6(115.2)	115.5	134.5
1972	122.6	127.4(119.5)	118.6	142.4
1973	125.7	131.0(123.0)	137.9	150.4
1974	141.4	145.3(137.1)	210.8	164.4
1975	161.0	160.0(152.0)	230.6	201.3

CBO INDEX				
INDEX NAME	IMPD, Equipment*	PXP**	PXP**	PXP**
YEAR				
1965	100.0	100.0	Same	Same
1966	102.0	103.1		
1967	105.2	105.9		
1968	107.6	110.2		
1969	110.9	115.7(100.0)		
1970	115.7	121.1(104.6)		
1971	119.8	126.6(109.4)		
1972	121.7	131.1(133.3)		
1973	125.1	138.6(119.8)		
1974	137.8	152.8(132.0)		
1975	155.4	166.6(143.9)		

* Implicit Price Deflator – Investment, Producers Durable Equipment

** Price of Gross Product For All Private Industry

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[1] Numbers in parentheses for the computed Utilities indices are computed from all given indices plus the Freight Rate Index, which was not available prior to 1969. PXP is normalized to base year 1969 in parentheses for comparison.

Table 4-1, (Continued)

PROXY, INDEX

OBJECT CLASS:	Equipment	Utilities	Supplies and Materials	Other Services
INDEX NAME:		GNP Deflator Services	CPI Fuel and Coal	GNP Deflator Structures
YEAR				
1965		100.0	100.0	100.0
1966		103.4	102.4	103.4
1967		107.5	105.7	107.3
1968		113.1	108.9	112.5
1969		119.0	111.6	121.6
1970		126.9	116.4	129.7
1971		135.1	124.2	138.4
1972		142.6	125.2	146.4
1973		150.4	143.8	159.8
1974		163.3	226.8	184.8
1975		175.2	248.7	203.8

or which are used to form a minor part of equipment or fixed property" [Ref. 7].

Examples of types of equipment in this object class are: transportation equipment; furniture, furnishings, and fixtures; books for permanent collections; implements and tools; machinery such as engines, generators, pumps, transformers, and ship equipment; instruments and apparatus such as surgical instruments, telephone and telegraph equipment, and electric equipment; armaments such as tanks, machine guns, submarine mine equipment, and many others.

Since the Navy does not have tanks or many machine guns, these items are of no concern. However, items such as submarine mine equipment must be ignored here due to the lack of a suitable index or weights. This is reasonable because various weapons are generally accounted for under procurement accounts.

The subgroups, their weights within the O&M,N account and the indices chosen to form the composite equipment index are shown in Table 4-2 below.

The indices shown in Table 4-2 do not represent the entire definition of items which fall into the object class Equipment. However, they do appear to represent the general class of items in the subgroups for which weights are available. The major items which are not represented are furniture and armaments.

Table 4-2

Components of Equipment

WEIGHT	SUBGROUP	SOURCE	INDEX TITLE
0.017	Communications and Industrial Machines, Equipment and Supplies	WPI	Electrical Machinery and Equipment 11-7
0.013	Vehicles and Equipment	WPI	Motor Vehicles and Equipment 14-1
0.009	Medical, Dental and Veterinary Equipment	WPI	Other Specialized Machinery 11-6
0.006	Federal Government Machinery, Excluding Electric	WPI	General Purpose Machinery 11-4

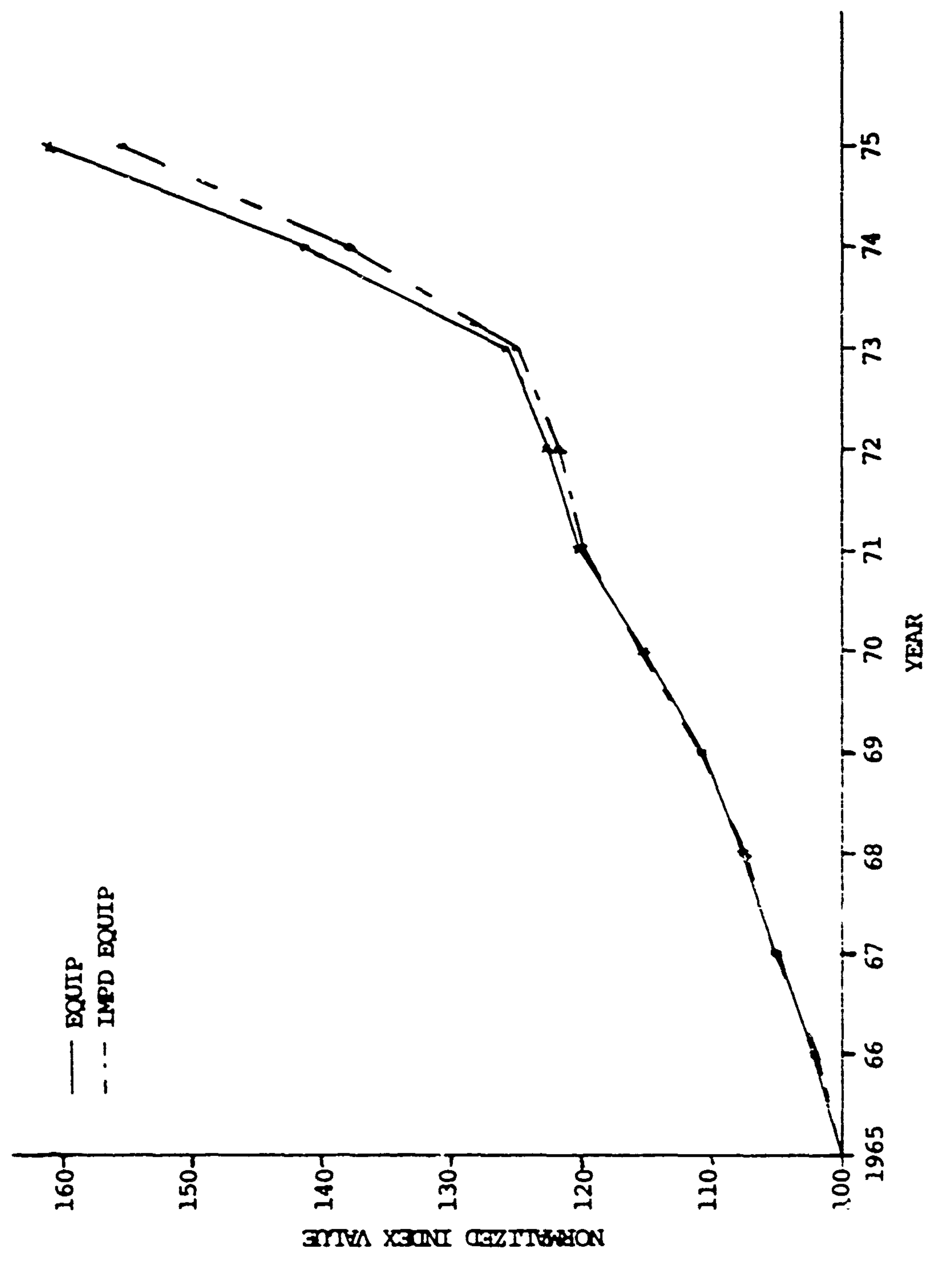
Note: Weights and basic subgroups from Ref. 11

One component index, WPI 11-6, Other Specialized Machinery, undoubtedly bears the least resemblance to those items which it is a proxy for of any in Table 4-2. Although the word "Specialized" is in the name, this index is representative of equipment used in specialized industries such as the woodworking industry, food products industry, and chemical industry. Therefore, although this machinery is in some sense specialized, it is not clear that WPI 11-6 truly represents the subgroup Medical, Dental, and Veterinary Equipment. The index was chosen by the RAC study, and a better one does not appear to exist. Therefore, the index WPI 11-6 was used in the composite index with some reservation.

The index used for the CBO model to represent the object class is the Implicit Price Deflator – Investment, Producers Durable Equipment. As stated in Chapter II, this index represents "all types of machinery, transportation equipment (automobiles, trucks, etc.), furniture and fixtures, engines and turbines, instruments, and other equipment." This index also appears to represent those items within the object class well. In this index, furniture is included, but electrical equipment, especially, appears to have little representation.

As shown in Graph 4-1, the two indices track very closely until 1971, being within 0.5 of each other. After 1971, the GNP deflator tracks slightly lower, growing at a slower rate. The composite equipment index appears to accelerate in the 1973-1974 period at a slightly faster pace than the GNP deflator. As shown, this change in the rates of growth, during a relatively high inflation period, has caused the two indices to separate. The 1974 annual average indices differ by 3.6 percent and the 1975 indices differ by 5.6 percent for a 1965 base year.

The weights for WPI 11-6 and WPI 11-4, Other Specialized Machinery and General Purpose Machinery, although smaller than the other two, are sufficient to have caused the separation in tracks of the GNP deflator and the composite equipment index. This is because WPI 11-4 and 11-6 are increasing more rapidly over the period than are Electrical



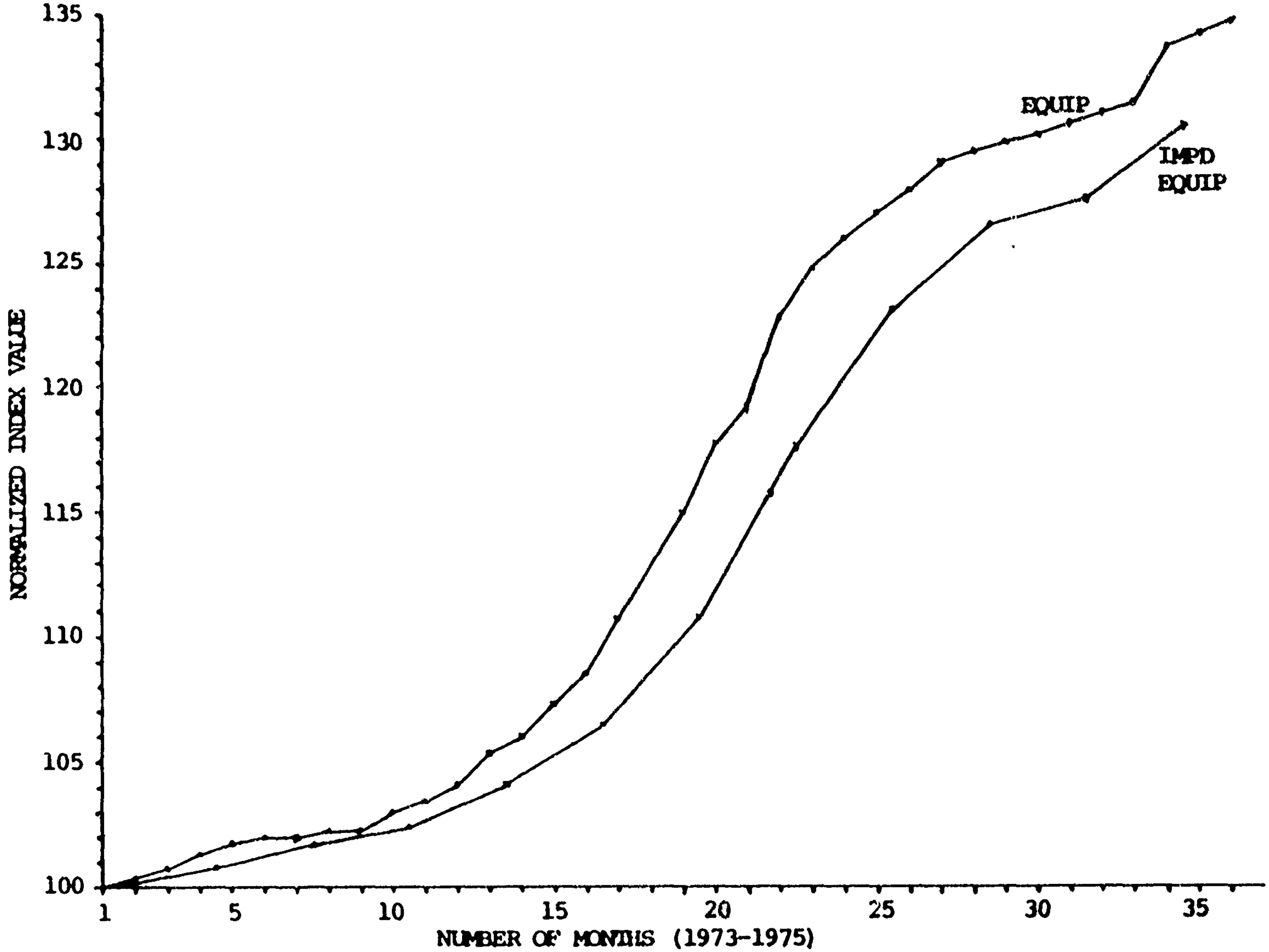
— EQUIP
- · - IMPD EQUIP
NORMALIZED INDEX VALUE
100
110
120
130
140
150
160
1965
66
67
68
69
70
71
72
73
74
75
YEAR

GRAPH 4-1

Machinery and Equipment, WPI 11-7, and Motor Vehicles and Equipment, WPI 14-1.

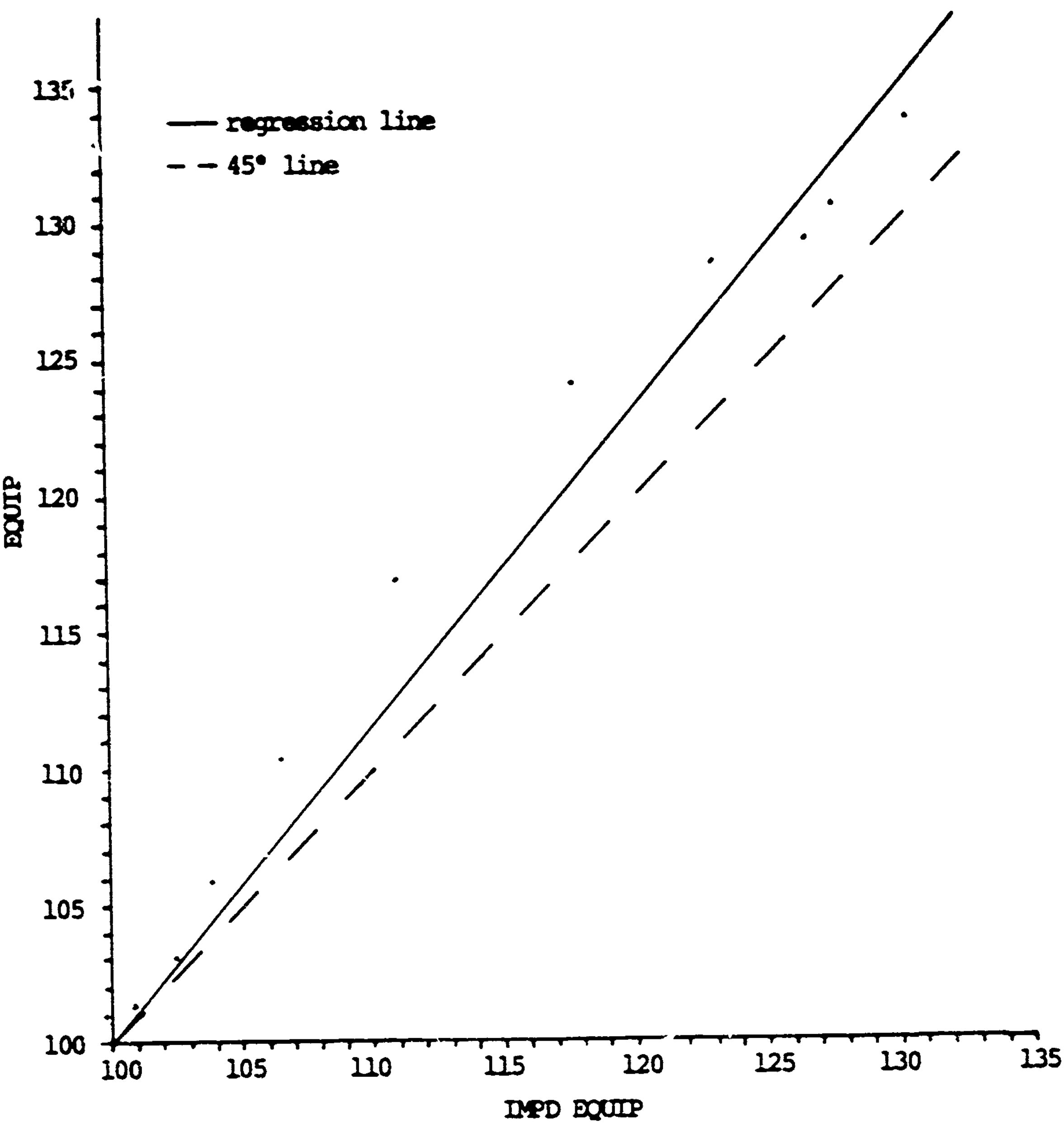
The results of the regressions for those mathematical models given above in Table 3-5 are presented in Appendix B. The tests of the hypothesis that the calculated index and the implicit price deflator have the same annual rate of increase was accepted for all models except one. Model 2 of Table 3-5 did not accept the hypothesis that the indices were the same. Graph 4-1 shows that both indices follow approximately a linear track until about 1973, and that the separation in tracks occurred mainly during the period 1973-1975. Further analysis was carried out for that period.

The tracks of the two indices are shown in Graph 4-2 for the period 1973-1975. The two tracks appear to have approximately the same form over this period, but their separation does become apparent. The data from this period was used to fit all of the mathematical models. Those results are given in Appendix B. Again, all models accepted the hypothesis that the rates of increase are the same except for Model 2. The results of Model 2 are shown in Graph 4-3. Further, the hypothesis that the two indices are the same using Model 1 is accepted only above the 0.05 level for this period, indicating that this model would also reject the hypothesis at the 0.01 level. Therefore, it can not be concluded with certainty that the two indices



135
130
125
120
115
110
105
100
NORMALIZED INDEX VALUE
EQUIP
IMPD
EQUIP
1
5
10
15
20
25
30
35
NUMBER OF MONTHS (1973-1975)

GRAPH 4-2



regression line
45° line
135
130
125
120
115
110
105
100
EQUIP
100
105
110
115
120
125
130
135
IMPD EQUIP

GRAPH 4-3

increased at the same rate over the high inflation period of 1973-1975.

B. UTILITIES

The object class Utilities was consolidated in the CBO model to include the object classes Transportation of Persons; Transportation of Things; Rent, Communications, and Utilities; and Printing and Reproduction.

Transportation of Persons is defined [Ref. 7] to include the "transportation of Government employees and others, their per diem allowances ..., and other expenses incident to travel." Transportation of Things is defined as "contractual charges for the transportation of things .... It includes postage and parcel cost, rental of trucks and other transportation equipment, and reimbursements to Government personnel for the authorized movement of household effects or house trailers." Rents include charges for "possession and use of land, structures, or equipment (other than transportation equipment)." Communication services include contractual charges for "land, telegraph service, telephone and teletype services ...; switchboard and service charges and telephone installation costs." Utility services includes "charges for heat, light, power, water, gas, electricity ..." Printing and reproduction includes "job work done on printing presses which utilize printers' type plates, or engraving; lithographing; ... mimeographing, binding, photostating, blueprinting, and photography, and microfilming."

The subgroups, their weights within the O&M,N account, and the proxy indices chosen are shown in Table 4-3.

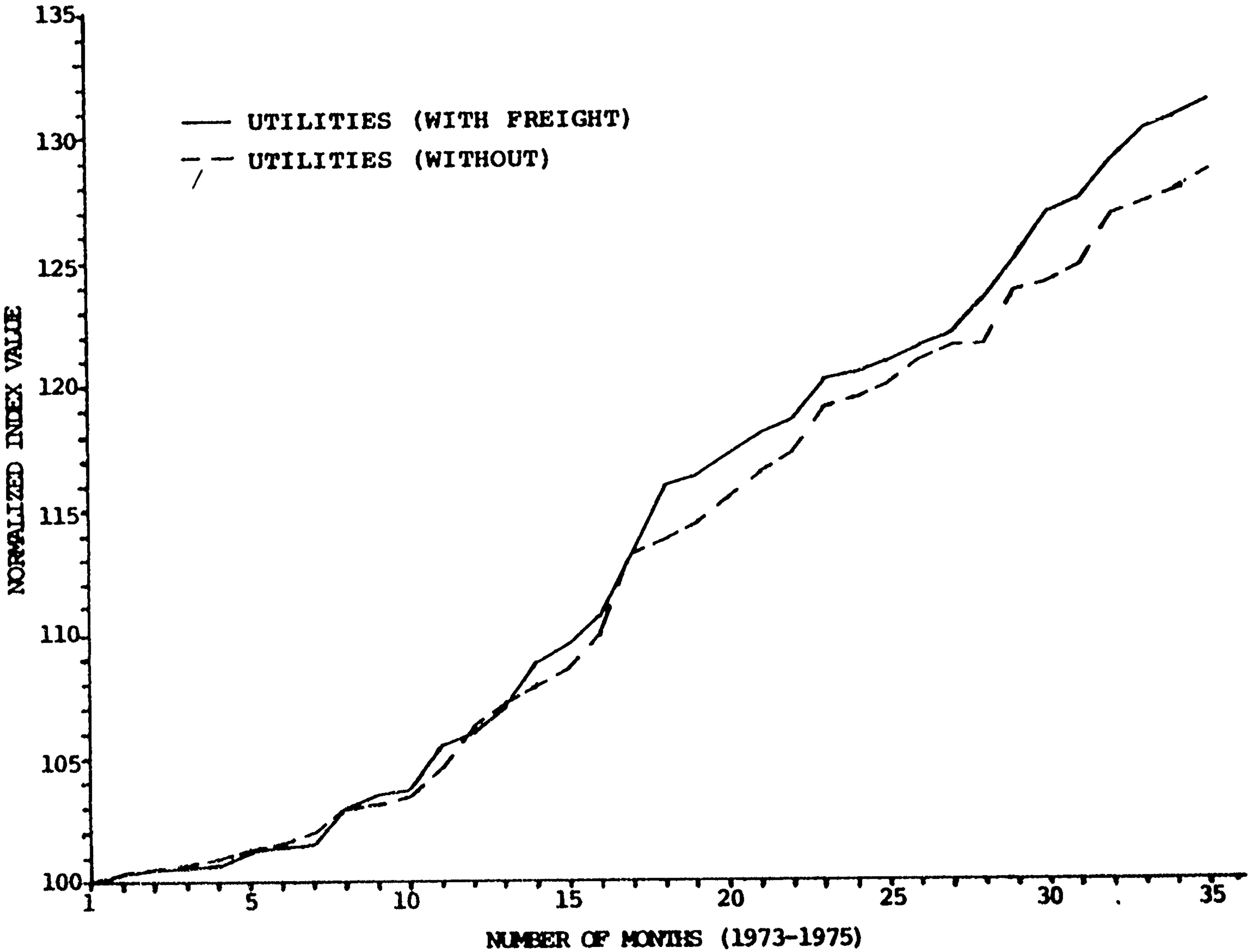
Table 4-3

Components of Utilities

WEIGHT	SUBGROUP	SOURCE	INDEX TITLE
0.033	Air and Air Private Carriers	CPI	Air Fares
0.024	Water	WPI	Freight Rate Index
0.014	Transportation Service	CPI	Public Transportation
0.020	Telephone and Telegraph	CPI	Telephone
0.014	Electric Companies and Systems	WPI	Electric Power 05-4
0.010	Communications Service	WPI	Switchgear, Switchboard 11-75

The Freight Rate Index did not exist prior to 1969. Therefore, two sets of indices were calculated. These are shown in Table 4-1. One index, which had the Freight Rate index as a component, was calculated for the period 1969 to 1975. The other, which excluded it, was calculated for the entire period. These indices are shown in Graph 4-4.

The two composite indices were tested for their equivalence using three of the mathematical models for the period 1973-1975. Monthly data was used. The results are shown in Appendix B. The hypotheses that the two indices were equivalent could not be accepted using any of the three models at the 0.05 level. Therefore, it must be concluded


UTILITIES (WITH FREIGHT)
UTILITIES (WITHOUT)
NORMALIZED INDEX VALUE
135
130
125
120
115
110
105
100
1
5
10
15
20
25
30
35
NUMBER OF MONTHS (1973-1975)

GRAPH 4-4

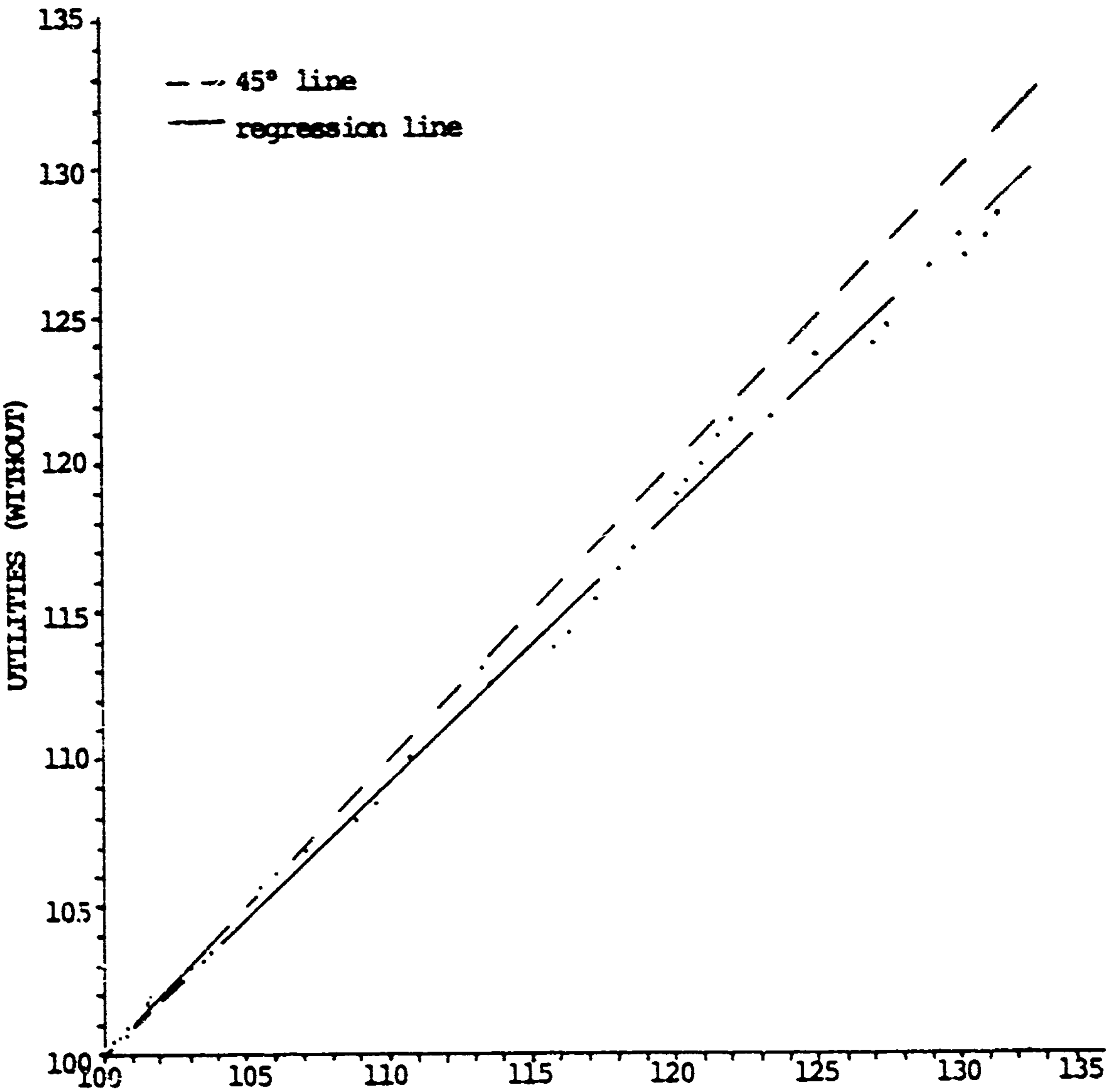
that the rates of increase of the two composite indices differ for this period. Graphical results for Model 2 are shown in Graph 4-5.

Although it was desirable to include the Freight Rate Index as a component of the Utilities index, the index which excluded it was used in the calculation of the composite O&M,N index in order to cover the entire period. The O&M,N index may be further downward biased by this.

The CBO has used the GNP deflator Price of Gross Product for All Private Industry, PXP, as a proxy index for modeling inflation for this object class. PXP and the composite Utilities index are shown in Graph 4-6. The Utilities composite index, which does not include the Freight Rate Index as a component, tracks consistently lower than PXP because of the great divergence in the tracks during the period 1965-1968. Thereafter, however, the rates of increase of the two indices do appear to be similar.

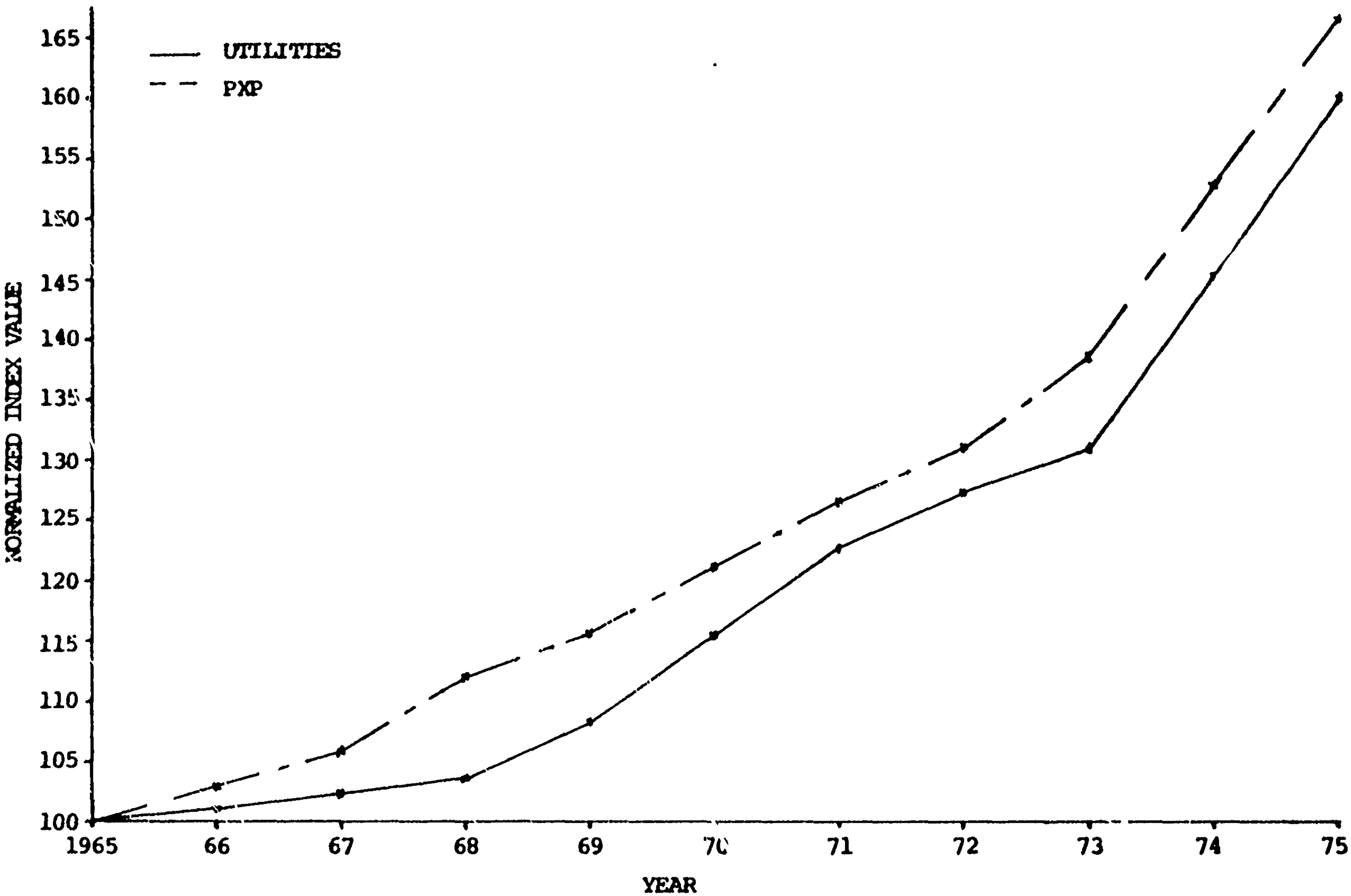
Comparing the composite Utilities index with PXP by using each of the mathematical models indicates that their rates of increase over the period 1965-1975 are indeed the same. Those results are presented in Appendix B. The hypothesis of equivalent rates of increase was accepted for each model.

A problem exists with the Price of Gross Product index, however, in that it is no longer published. Therefore, alternatives to it which might track closely with the composite Utilities index and bear some logical relation



135
130
125
120
115
110
105
100
100
105
110
115
120
125
130
135
45° line
regression line
UTILITIES (WITHOUT)
UTILITIES (WITH)

GRAPH 4-5


UTILITIES
PXP
NORMALIZED INDEX VALUE
165
160
155
150
145
140
135
130
125
120
115
110
105
100
1965
66
67
68
69
70
71
72
73
74
75
YEAR

GRAPH 4-6

to the types of goods and services represented by the object class were examined. The closest found was the GNP deflator for Services.

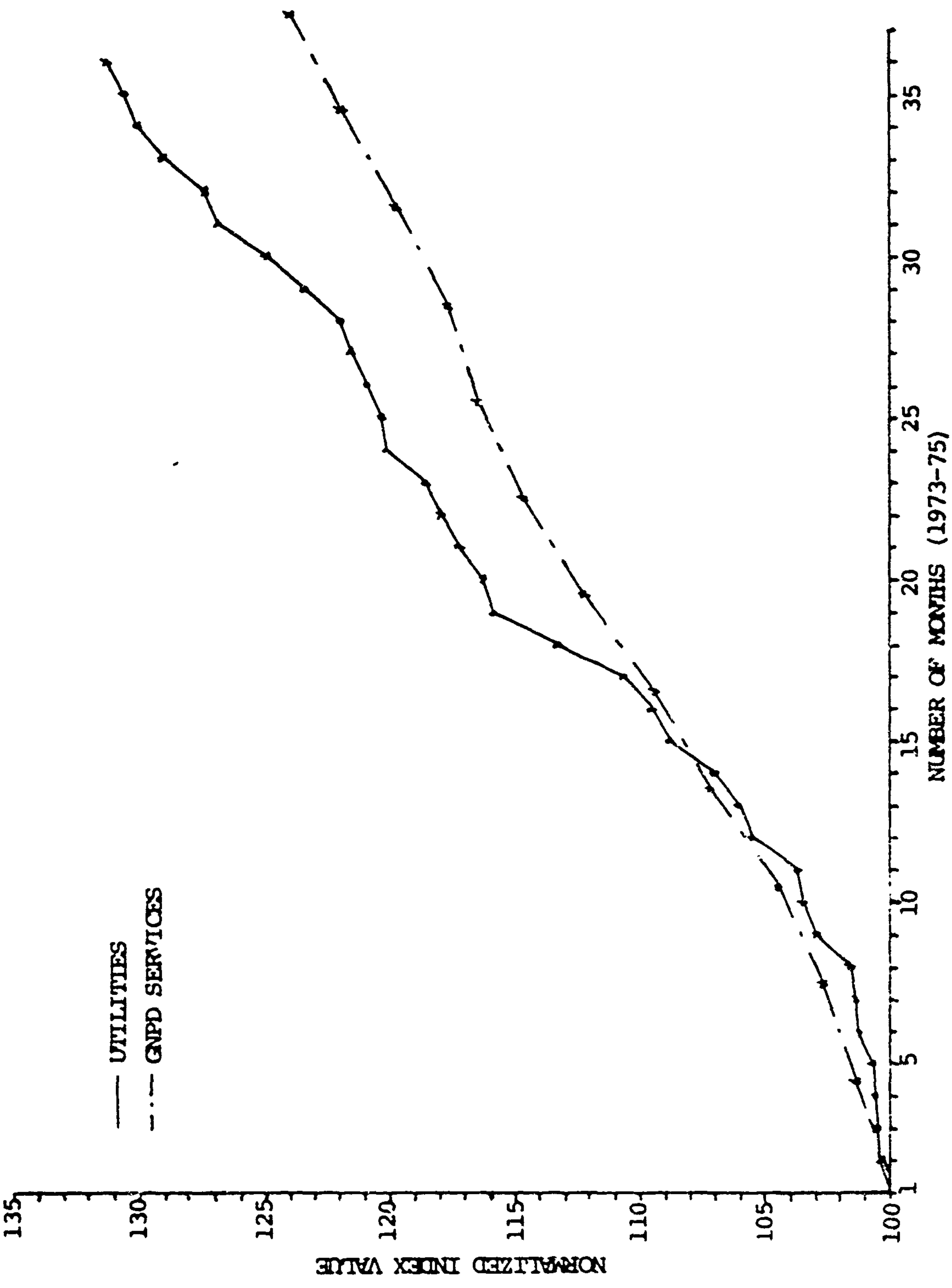
A comparison was made between the GNP deflator for Services and the Utilities index for the period 1965-1975. However, as shown in Appendix B, the hypotheses that the rates of increase are the same could not be accepted for any of the four models.

A further comparison was made between the Utilities index which had the Freight Rate Index as a component and the GNP deflator for Services. The data was for the period 1973-1975. The Utilities index was averaged for each quarter of that period because the GNP deflator is published as a quarterly index.

The tracks of the two indices are shown in Graph 4-7 for the 1973-1975 period. The mathematical models were used and, as one would expect from Graph 4-7, none of the hypotheses could be accepted. The results of the tests are included in Appendix B.

C. OTHER SERVICES

This object class accounts for contractual services not otherwise classified in the budget. It includes some supplies and materials which are furnished by a contractor. Examples are: repair and alterations of buildings, bridges, vessels, equipment, etc; maintenance of vehicles; stenographic services; advertising; operation of facilities;



UTILITIES
GNPD SERVICES
NORMALIZED INDEX VALUE
100
105
110
115
120
125
130
135
1
5
10
15
20
25
30
35
NUMBER OF MONTHS (1973-75)

GRAPH 4-7

research and development contracts, and contractual care for subsistence and lodging of persons [Ref. 7]. It should again be noted that this object class implicitly includes wages and benefits for civilians.

The subgroups, their weights within the O&M,N account, and the proxy indices chosen are shown in Table 4-4 below.

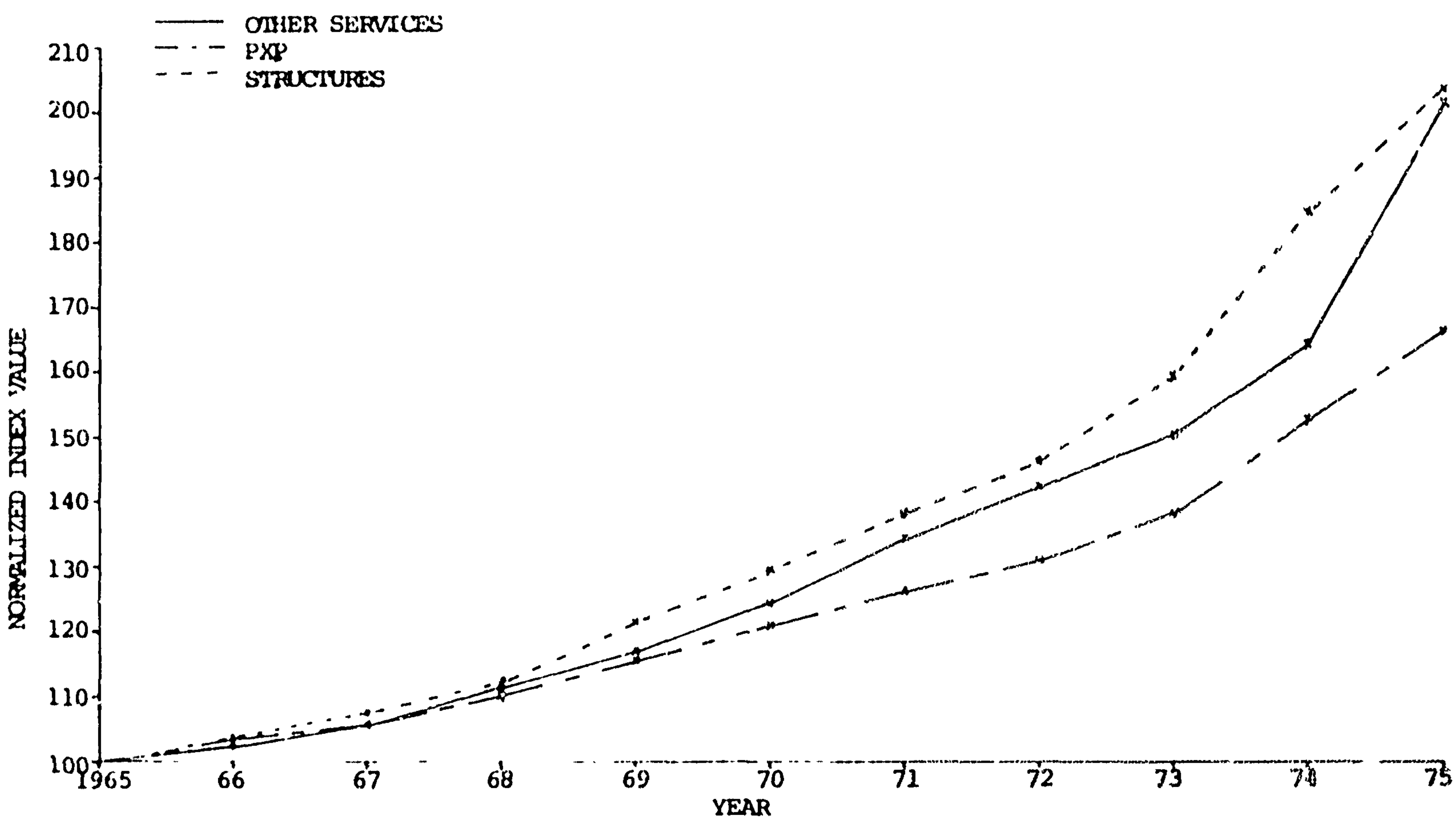
Table 4-4

Components of Other Services

WEIGHT	SUBGROUP	SOURCE	INDEX TITLE
0.093	Maintenance and Repair Equipment	CPI	Auto Repairs
0.099	Equipment Repair and Maintenance	WPI	Railroad Equipment 14-4
0.070	Operation and Maintenance of Government Facilities	CPI	Maintenance and Repair of Housing
0.094	Modification, Alteration, and Rebuilding; Architectural, Engineering, and Technical Repair Service	Survey of Current Business	Engineering News-Record, Building

The most notable category of expense not accounted for here explicitly is the repair and alteration of vessels.

For this object class, the CBO has again used the index Price of Gross Product for All Private Industry, PXP. As shown in Graph 4-8, PXP increases at a lower rate over the entire period of 1965-1975. Its average annual rate of


OTHER SERVICES
PXP
STRUCTURES
NORMALIZED INDEX VALUE
210
200
190
180
170
160
150
140
130
120
110
100
1965
66
67
68
69
70
71
72
73
74
75
YEAR

GRAPH 4-8

increase from 1965 to 1973 is 4.2%, as compared to the tailored index's average annual rate of increase of 5.2%. From 1973 to 1975 PXP, increases at an annual average rate of 9.6% while the tailored index increases at an annual average rate of 15.8%.

Tests of the hypotheses of equivalence from the results of each of the models, as would be expected. rejected the hypotheses. These results are presented in Appendix B.

As an alternative to PXP, the index which appeared to bear the closest logical resemblance, and also track the closest to the tailored Other Services index was the GNP deflator for Structures. This index is also shown in Graph 4-8.

The mathematical models were used to compare the Other Services index and the GNP deflator for Structures. Tests of the hypotheses for equivalence of the indices were done, and the hypotheses were accepted for each of the models except Model 2. Examination of the data shows that Model 2 is sensitive to the rather large difference in values of the indices from 1973 to 1974. Further, it should be pointed out that Model 1 only marginally accepted the hypothesis at the 0.05 level.

These results are therefore ambiguous, and it cannot be concluded that the GNP deflator and the Other Services index are indeed similar in their rates of increase for this period.

D. SUPPLIES AND MATERIALS

This object class "comprises all commodities whether acquired by formal contract or other form of purchase, (a) which are ordinarily consumed or expended within one year after they are put into use, or (b) which are converted in the process of construction or manufacture, or (c) which are used to form a minor part of equipment or fixed property" [Ref. 7].

Examples include: office supplies; chemicals; surgical and medical supplies; subscriptions to publications; fuels; clothing, provisions; cleaning supplies; ammunition and explosives; construction, repair, or production materials.

The subgroups, their weights within the O&M,N account, and the proxy indices chosen are shown in Table 4-5.

Table 4-5

Components of Supplies and Materials

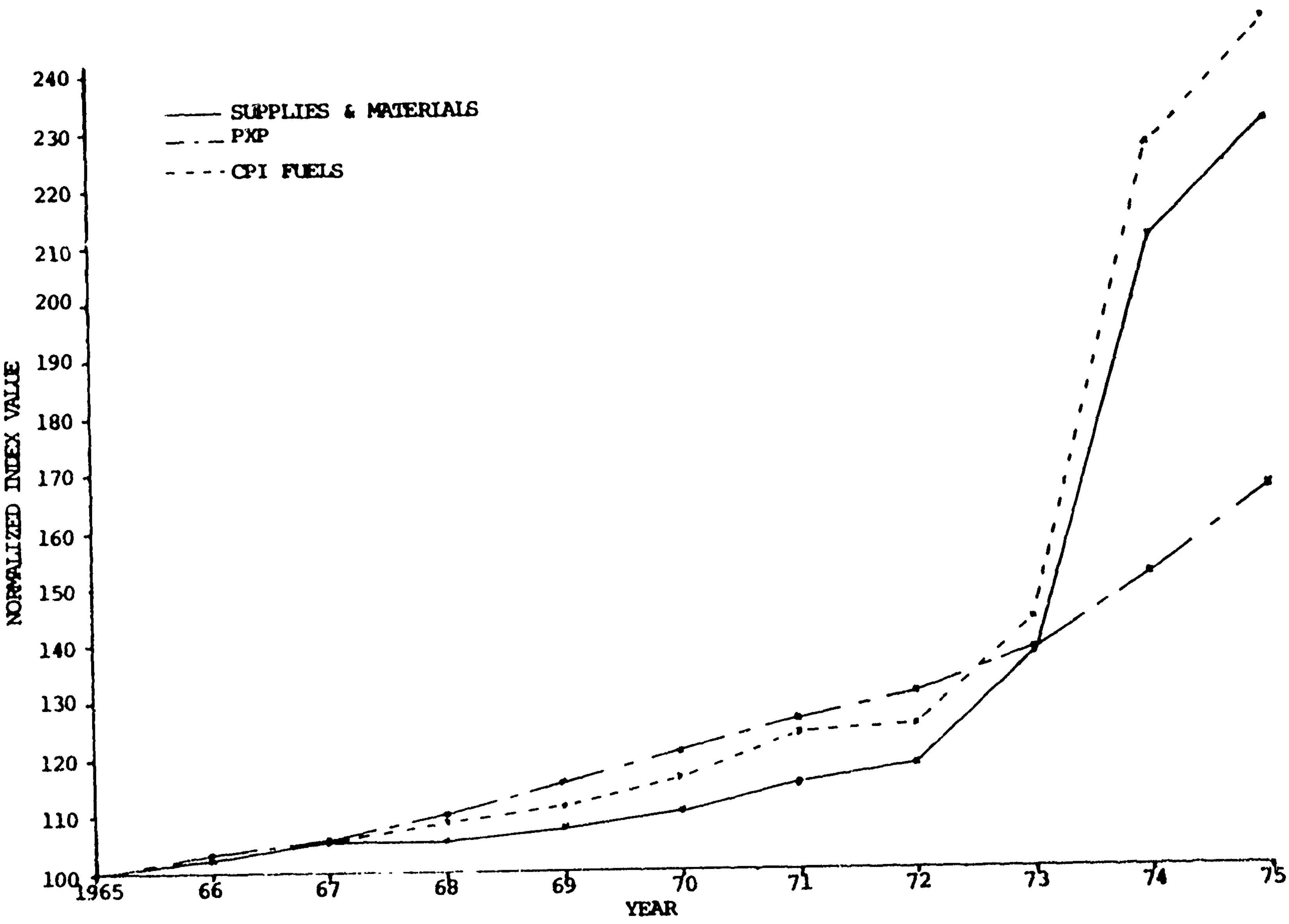
WEIGHT	SUBGROUP	SOURCE	INDEX TITLE
0.129	Fuel, Lubricating Oils and Wax	WPI	Petroleum Products, Refined 05-7
0.024	Subsistence	WPI	Farm Products and Processed Foods and Feeds
0.016	Training Aids	CPI	Reading Recreation
0.006	Tires and Tubes	WPI	Tires 07-00
0.006	Containers and Packaging	WPI	Pulp, Paper, and Allied Products 09-00
0.066	Books, Maps, etc.	WPI	Paper 09-13
0.020	Ordnance and Accessories	WPI	Explosives 06-79 Small Arms 15-13 Finished Steel 10-13 Ordnance and Munitions Labor

Ordnance and Accessories is a composite index of the three WPI indices used. The weights and indices are similar to those recommended by the Office of the Secretary of Defense for ordnance procurement [Ref. 1]. The weights used in forming the index were 0.5 for labor and 0.5 for material. The material portion of the index was formed with weights 0.6, 0.2, 0.2, respectively.

Since this object class includes fuels, the constructed index shows an extremely high rate of increase from 1973 to 1975. The volatility of the index is evident because of the relatively large weight for fuel.

In 1975, Fuels accounted for approximately 12.9% of O&M,N. Replacing the RAC weight (0.178) by 0.129 produced only a slight change in the values of the composite index for the years 1965 to 1973, but the values were reduced by about 6 points in 1974 and 1975. This was because of the large increase in the WPI Fuels Index (05-7) to values well over 200 in these two years, far greater than the other indices used to form the index. Therefore, the sensitivity to the weight used for fuel becomes apparent.

Again the CBO used the deflator, Price of Gross Product for all Private Industry, PXP, as its measure of inflation for Supplies and Materials. As shown in Graph 4-9, the disparity in the tracks of the two indices is extreme. In the years following 1972, PXP does not increase even comparably to the increase shown in the tailored index. By



SUPPLIES & MATERIALS
PXP
CPI FUELS
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
1965
66
67
68
69
70
71
72
73
74
75
NORMALIZED INDEX VALUE
YEAR

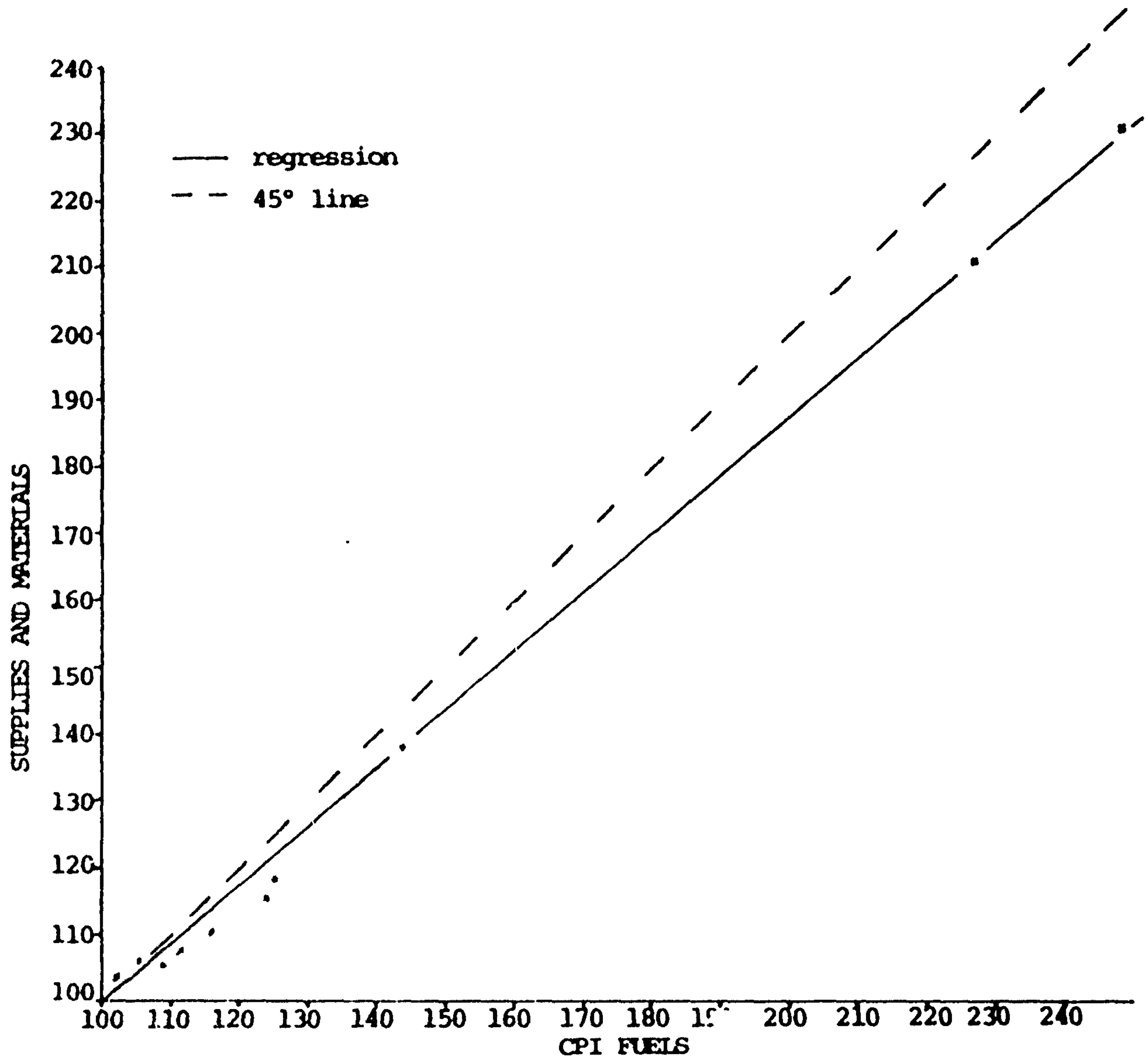
GRAPH 4-9

1975 the difference in values is 86.7 points. Obviously, PXP did not reflect well the fuel crisis.

An alternative index which more closely approximated the path of the Supplies and Materials tailored index was the CPI component Fuel Oil and Coal. As shown in Graph 4-9, the CPI component may overestimate inflation for Supplies and Materials after 1967. From 1965 to 1972, the average annual rate of increase of the CPI component is 3.3% and that of the tailored index is 2.5%. From 1972 to 1975, the CPI component increased at the average rate of 27.4% per annum while the tailored index rose at the rate of 26.2% per annum.

Both the CPI component and the tailored index reflect the huge price increases in fuel after 1972. This is to be expected. However, the tailored index does behave in a more moderate fashion because of the other non-fuel related indices which compose it. All components of the tailored index showed marked increases after 1972 except for the CPI component Reading and Recreation which was used as a proxy for Training Aids.

Tests of hypotheses for the equivalence of the Supplies and Materials index and the CPI component are presented in Appendix B. The hypotheses were accepted for each model except Model 2. The results for Model 2 are shown in Graph 4-10.


regression
45° line
SUPPLIES AND MATERIALS
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
100 110 120 130 140 150 160 170 180 200 210 220 230 240
CPI FUELS

GRAPH 4-10

E. OPERATION AND MAINTENANCE, NAVY

Composite indices were computed for the O&M,N account using those indices developed for each of the object classes. In addition, those proxy indices used by the CBO were combined to form an index which may be representative of the inflation experienced by the account. This index may be called CBO.

Another index was formed using the other proxy indices. That index may be called Other Proxy. Since another proxy index was not compared for the object class Equipment, and it is believed that the Implicit Price Deflator for Equipment may represent the inflation of that object class reasonably well, this index was used in the computation of the Other Proxy index.

The results of these calculations are shown in Table 4-5 for the 1965-1975 period.

Table 4-6

Possible Indices for the O&M,N Account

O&M,N	CBO	OTHER PROXY
100.0	100.0	100.0
102.5	103.1	103.2
105.3	105.9	106.9
108.9	110.2	111.6
113.6	115.7	118.8
119.8	121.1	126.0
128.3	126.6	134.4
134.5	131.1	140.5
144.6	138.6	154.5
173.2	152.8	191.2
205.7	166.6	211.2

As Graph 4-11 shows, the CBO Index tracks fairly well with the O&M,N index until 1970, and increases at a lower rate thereafter. By 1975, there is a large difference in the values of the indices.

The Other Proxy index, on the other hand, is of approximately the same form over the entire period, but tracks above the O&M,N index.

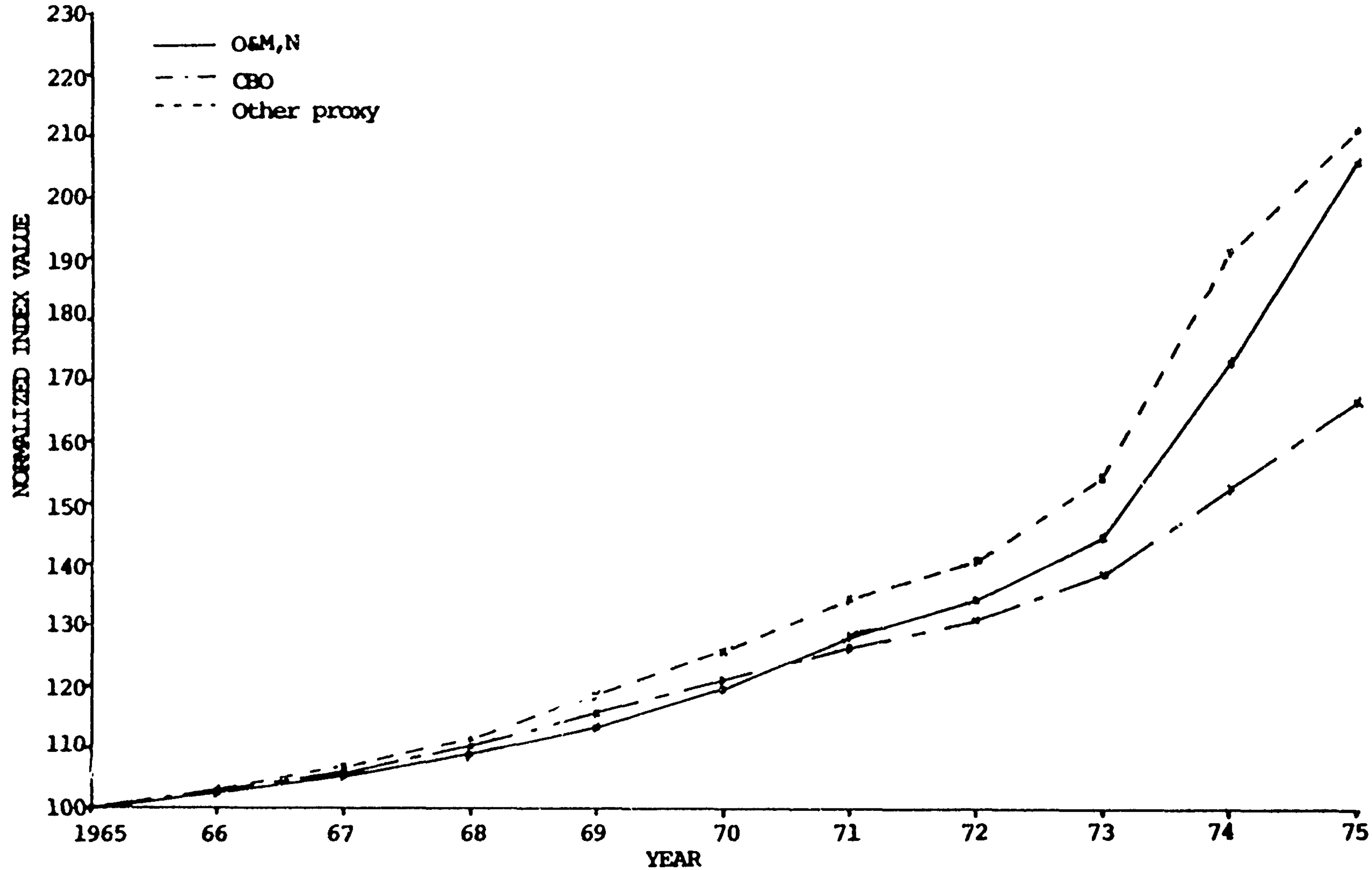
The mathematical models were again used to estimate the rates of increase of each index, and those results are shown in Appendix B.

For each of the models, the hypothesis that the rates of increase for the O&M,N index and CBO index were the same could not be accepted. The data indicates that this is probably because of the extreme difference in the behavior of the two indices over the high inflation period of 1972-1975.

The statistical comparison of the O&M,N index and Other Proxy index was divided in the results. The linear models, which regressed one index upon the other, each rejected the hypothesis that the indices were the same. However, the exponential models, which regressed the indices on ordinal time, each accepted the hypothesis.

F. CONCLUSIONS AND RECOMMENDATIONS

This study has presented three possible sets of indices for the eleven year period 1965-1975 which may measure the inflation that has occurred within the Operation and


O&M,N
CBO
Other proxy
230
220
210
200
190
180
170
160
150
140
130
120
110
100
NORMALIZED INDEX VALUE
1965
66
67
68
69
70
71
72
73
74
75
YEAR

GRAPH 4-11

Maintenance, Navy budgetary account, excluding personnel compensation and benefits. There exists uncertainty that any two of the three are the same in their statistical rates of increase. This applies, in general, to the object classifications as well as the material portion of the account as a whole.

However, the O&M,N index was constructed through the dissaggregation of the O&M,N account into object classifications, and further into subgroups. If the O&M,N index, constructed in this thesis, does approximate the "true" index for the account, then, as shown in Tables 4-1 and 4-6, the indices used by the Congressional Budget Office have substantially underestimated the effects of inflation upon the O&M,N account.

It is recommended that the components of the O&M,N index be used in the CBO's Five Year Projections for the O&M,N account. However, because of the number of indices used to form the components of that index, it may be more practical to use the components of the Other Proxy index. These components are logically related to the goods and services within each object class. Although not proven statistically the same in all cases, the Other Proxy index does track much closer to the O&M,N index than the CBO index. Comparison of the components of the O&M,N index with other available indices is an area for further research, in that the Other Proxy index could possibly be improved to statistically match the computed O&M,N index.

APPENDIX A

Operation and Maintenance, Navy

For expenses, not otherwise provided for, necessary for the operation and maintenance of the Navy and the Marine Corps, as authorized by law; and not to exceed [$3,707,000] *$4,239,000* can be used for emergencies and extraordinary expenses, as authorised by section 7202 of title 10, United States Code, to be expended on the approval or authority of the Secretary of the Navy, and payments may be made on his certificate of necessity for confidential military purposes: [$7,151,175,000] *$8,320,000,000* of which not less than [$235,000,000] *$200,000,000* shall be available only for the maintenance of real property [facilities: *Provided*, That of the total amount of this appropriation made available for the alteration, overhaul, and repair of naval vessels, not more than $1,130,000,000 shall be available for the performance of such work in Navy shipyards] *facilities, and in addition $64,000,000 for liquidation of contract authority in "Operation and maintenance, Navy" for fiscal year 1972.*

For "Operation and maintenance, Navy" for the period July 1, 1976, through September 30, 1976, $2,234,500,000 of which not to exceed $1,060,000 can be used for emergencies and extraordinary expenses. (5 U.S.C. 503, 3101, 3109, 5342, 5702–4, 5724, 5730, 5742, 5912, 5941, 5943–44, 7903; 10 U.S.C. 265, 276, 351, 951, 1037, 1071–85, 1125, 1481–88, 2110, 2127, 2602, 2632, 2674–75, 5012–13, 5031, 5151, 6022, 6028–9, 6153, 6201–3, 6951–2, 6968, 7041, 7043–4, 7085, 7202, 7205, 7207–9, 7212, 7214, 7229, 7293, 7297, 7303, 7361–2, 7391–2, 7394–6, 7421, 7432, 7571, 7580; 24 U.S.C. 14a, 16a, 21a, 37; 31 U.S.C. 22a, 104, 725h; 33 U.S.C. 367; 37 U.S.C. 404; 39 U.S.C. 406, 2601, 3208; 44 U.S.C. 1321; Department of Defense Appropriation Act, 1976.)

Program and Financing (in thousands of dollars)

	Ident. code 07-10-1804-0-1-051	1974 actual	1975 est.	1976 est.
	Program by activities:			
	Direct program:			
	1. Strategic forces	353,539	490,230	598,565
	2. General purpose forces	2,628,149	3,175,037	3,751,463
	3. Intelligence and communications	312,710	347,235	400,562
	7. Central supply and maintenance	2,159,701	2,287,314	2,494,105
	8. Training, medical, and other general personnel activities	833,645	753,887	817,378
	9. Administration and associated activities	247,465	231,012	256,767
	10. Support of other nations	21,289	760	1,159
	Total direct program	6,556,518	7,285,475	8,320,000
	Reimbursable (total)	1,458,179	1,5[illegible]00	1,523,899
	Subtotal	8,014,697	8,785,475	9,843,899
	Intrafund obligations	−811,001	−840,000	−840,000
10	Total obligations	7,203,696	7,945,475	9,003,899
	Financing:			
	Receipts and reimbursements from:			
11	Federal funds	−584,448	−603,000	−626,899
13	Trust funds	−27,470	−28,000	−28,000
14	Non-Federal sources	−19,399	−29,000	−29,000
21.40	Unobligated balance available, start of year	−18,251		
25.40	Unobligated balance lapsing	39,967		
	Budget authority	6,594,096	7,285,475	8,320,000

	Budget authority:			
40	Appropriation	6,577,125	7,151,175	8,374,000
	Appropriation (indefinite)	22,138	----------	----------
	Rescission of enacted appropriation now pending	----------	−27,500	----------
40.49	Portion applied to liquidate contract authority	----------	----------	−54,000
41	Transferred to other accounts	−5,167	----------	----------
43	Appropriation (adjusted)	6,594,096	7,123,675	8,320,000
44.10	Proposed supplemental for wage-board pay raises	----------	100,000	----------
44.20	Proposed supplemental for civilian pay raises	----------	61,000	----------
	Relation of obligations to outlays:			
71	Obligations incurred, net	6,572,379	7,285,475	8,320,000
	Obligated balance, start of year:			
72.40	Appropriation	981,388	1,591,409	1,848,884
72.49	Contract authority	64,859	52,676	54,000
	Obligated balance, end of year:			
74.40	Appropriation	−1,591,409	−1,848,884	−2,248,884
74.49	Contract authority	−52,676	−54,000	----------
	Adjustments in expired accounts:			
77.40	Appropriation	−1,862	----------	----------
77.49	Contract authority	−12,183	1,324	----------
90	Outlays, excluding pay raise supplemental	5,960,497	6,881,571	7,958,629
91.10	Outlays from wage-board pay raise supplemental	----------	91,224	9,576
91.20	Outlays from civilian pay raise supplemental	----------	55,205	5,795

Note.—Estimates in 1975 and 1976 exclude activities transferred to Military Assistance, South Vietnamese Forces. 1974 amounts included above $17,600 thousand.

Status of Unfunded Contract Authority (in thousands of dollars)

	1974 actual	1975 est.	1976 est.
Unfunded balance, start of year	64,859	52,676	54,000
Administrative restoration or cancellation (−) of unfunded balance	−12,183	1,324	--------
Unfunded balance, end of year	−52,676	−54,000	--------
Appropriation to liquidate contract authority	--------	--------	54,000

Object Classification (in thousands of dollars)

Identification code 0- 3-1804-0-1-051		1974 actual	1975 est.	1976 est.
	Personnel compensation:			
11.1	Permanent positions	1,324,168	1,474,130	1,511,975
11.3	Positions other than permanent	45,348	36,991	27,971
11.5	Other personnel compensation	65,105	63,325	69,658
	Total personnel compensation	1,434,621	1,574,446	1,609,604
	Direct obligations:			
	Personnel compensation	1,180,879	1,367,082	1,275,857
12.1	Personnel benefits: Civilian	111,160	123,007	126,357
13.0	Benefits for former personnel	1,164	1,272	813
21.0	Travel and transportation of persons	97,985	81,890	95,000
22.0	Transportation of things	193,522	203,745	216,439
23.0	Rent, communications, and utilities	277,020	378,310	426,680
24.0	Printing and reproduction	26,069	28,960	34,570
25.0	Other services	3,669,815	3,788,590	4,630,643
26.0	Supplies and materials	966,385	1,370,956	1,472,627
31.0	Equipment	32,519	41,663	41,014
	Total direct obligations	6,556,518	7,285,475	8,320,000
	Reimbursable obligations:			
	Personnel compensation	253,742	307,364	333,747
12.1	Personnel benefits: Civilian	23,886	29,839	33,053
13.0	Benefits for former personnel	18	208	195
21.0	Travel and transportation of persons	2,500	2,500	2,560
22.0	Transportation of things	230	230	230
23.0	Rent, communications, and utilities	36,000	37,000	37,000
24.0	Printing and reproduction	600	600	600
25.0	Other services	946,403	918,459	910,174
26.0	Supplies and materials	191,000	200,000	202,540
31.0	Equipment	3,800	3,800	3,800
	Total reimbursable obligations	1,458,179	1,500,000	1,523,699
	Subtotal	8,014,697	8,785,475	9,843,899
96.0	Intrafund obligations	−811,001	−840,000	−840,000
99.0	Total obligations	7,203,696	7,945,475	9,003,899

Personnel Summary

Total number of permanent positions	123,524	124,385	126,072
Full-time equivalent of other positions	4,973	3,809	2,612
Average paid employment	123,158	127,576	126,915
Average GS grade	7.34	7.31	7.28
Average GS salary	$13,048	$13,690	$13,939
Average salary of ungraded positions	$10,0[illegible]4	$11,076	$11,621

DEPARTMENT OF THE NAVY
OFFICE OF THE COMPTROLLER
WASHINGTON D.C. 20350

IN REPLY REFER TO

NAVCOMPTINST 7301.20C
NCB-1

21 AUG 1974

NAVCOMPT INSTRUCTION 7301.20C

From: Comptroller of the Navy

Subj: Report on obligations by object class; revised procedures for

Ref: (a) NavCompt Manual, Vol. 2, Chapter 6, Part A
(b) Treasury Department Circular No. 1073, Procedures Memorandum No. 1
(c) NavCompt Manual, Vol. 2, Chapter 2, Part C

Encl: (1) Percentage Report on Obligations (NavCompt Form 225A)
(2) Report on Obligations (Standard Form 225)

1. Purpose. To provide for automated monthly report of obligations incurred by object class as defined in reference (a) against unexpired appropriation accounts, including certain other related transactions and balances.

2. Cancellation. NAVCOMPTINST 7301.20B of 18 Dec 1967 is canceled.

3. Background

a. Authority. The subject reporting requirement has been imposed by the Treasury Department on all agencies of the Federal Government. However, reference (b) states:

"It is intended that this report be prepared with minimal burden to the agencies, maximizing the use of existing records and procedures. The installation of new formal records for the purpose of this report is not contemplated. Agency officials are expected, in determining the distribution of obligations by object class, to use whatever practical approach will result in a reasonably accurate breakdown for reporting on a most timely basis."

b. Policy. Ideally, actual accounting system data should be used to report object class obligations. However, the full display of actual object class obligations across all affected accounts is not currently available. Consequently, the Navy will continue to prepare the reports on an estimated basis from the best available information. Responsible offices are relieved of the monthly SF 225 reporting requirement, and will instead, submit quarterly Percentage Report on Obligations by Object Class (NavCompt Form 225A) reports.

c. Responsibility. NavCompt Form 225A, attached as enclosure (1), will be prepared at least quarterly for each account by the responsible office designated in reference (c). Based on these reports, the Comptroller of the Navy (Financial Control Division (NCB-3)) will prepare a monthly Standard Form 225, attached as enclosure (2), for each account.

4. Accounts covered. The prescribed SF 225 will be prepared for all funds available to Navy where it can reasonably be expected that the amount to be reported during the current fiscal year will exceed $1 million in any one section of the SF 225 (excluding section III, the total net obligations incurred), except:

a. Deposit fund accounts,

b. Foreign currency (FT) accounts.

In the case of transfer appropriation accounts derived from appropriations of other government agencies, the Navy will report directly to the Treasury, not via the parent appropriation and agency. Likewise, other government agencies will report directly to Treasury on transfer accounts derived from Navy appropriations.

5. Percentage report on obligations

a. General. A NavCompt Form 225A will be prepared for each current year unexpired appropriation or fund account by the designated responsible offices. Each report will provide percentages to two decimal places on gross obligations by object class for both Total Transactions, column (3), and within Federal Government only, column (4). The object classes reported for a given account on the NavCompt Form 225A must coincide with the object classes shown in the Congressional budget for that account. Prior to use of any object class not listed in the budget, approval must be secured from the Office of the Comptroller of the Navy (Budget Policy and Management Division (NCB-5)). All percentages shown will be cumulative for the year to date, and will be the best estimate available in accordance with subpar. 3.a.

b. Submission schedule. The basic reporting period will be quarterly with an additional report required for June. The due dates for NavCompt Form 225A are as follows:

Reporting period covered	Due date
July, August	15 August
September, October, November	15 October
December, January, February	15 January
March, April, May	15 April
June (Preliminary)	5 August

While the schedule provides the minimum reporting requirements, more frequent reports may be submitted by the responsible offices. Any additional reports must be submitted no later than 15 calendar days after the end of the monthly reporting period for which the report is applicable.

c. Report headings. Entries will be made for Agency; Appropriation Fund Title; Bureau; and Unexpired Accounts, Current Year Symbols as follows:

(1) Agency. Enter "Department of the Navy."

(2) Appropriation or Fund Title. Enter the appropriation or fund title as indicated in reference (c).

(3) Bureau. Enter the name of the bureau, command or office preparing the report.

(4) Unexpired Accounts, Current Year Symbol(s). Enter the symbol of the unexpired account as shown in reference (c).

d. Gross obligations by object class

(1) Total Transactions, Column (3). Percentage entries must be made, including zero entries, for all object classes listed in the budget for a given account. If an object class is not contained in the budget, then the corresponding line of column (3) should be blank. Since the total of column (3) represents the cumulative total of all obligations against that account for the year, the sum of all entries in column (3) should equal 100%.

(2) Within Federal Government only, Column (4). The percentages reported in column (4) should represent those portions of column (3) which meet the definition of "obligations incurred to make a payment to some other officially established appropriation, fund, or receipt account of the Federal Government (including trust funds but not deposit funds)." In this connection, as the form indicates, certain object classes are considered in their entirety as not being within the Federal Government, and no amounts should be reported in the shaded areas of column (4). Conversely, for object class 12, "Personnel benefits," it is to be assumed that all obligation transactions except as noted below are within the Federal Government; therefore, for this item the percentage reported in column (4) should read 100%, i.e., all of the percentage reported in column (3) is applicable to column (4). The exceptions to the object class 12 reporting are Military Personnel, Navy; Reserve Personnel, Navy; Military Personnel, Marine Corps; and Reserve Personnel, Marine Corps. For those four accounts, only the estimated percentage of column (3) applicable to Servicemen's Group Life Insurance (SGLI) and Federal Insurance Contributions Act (FICA) will be reported in column (4).

The percentages for SGLI and FICA will be shown as a footnote at the bottom of the NavCompt Form 225A and together will equal the percentage shown for object class 12 in column (4).

6. Report on obligations

a. General. For each account, based on the quarterly NavCompt Form 225A and the monthly Report on Budget Execution (DD Form 1176), a SF 225 will be prepared by NCB-1.

b. Report headings. Entries will be made for Agency; Appropriation or Fund Title; Bureau; and Unexpired Accounts, Current Year Symbols in accordance with Part 5c above.

c. Section I - Gross Obligations by Object Class

(1) General. Based on current year transactions for unexpired appropriations on line 7 (Obligations Incurred) of the DD Form 1176, entries for object class obligations will be calculated from the NavCompt Form 225A percentage estimates.

(2) Total Transactions, Column (3). Entries for each object class will be calculated based on the following equation:

(% from NavCompt Form 225A) X (DD Form 1176 line 7) = SF 225 entry.

The Total Section I line must agree with the line 7 of the DD Form 1176 for the current year unexpired appropriations.

(3) Within Federal Government only, Column (4). Entries to this column should represent those portions of column (3) which meet the definition stated in 5d(2). No entries will be made for object classes 11, 13, 41, 42, and 44 as indicated on the form itself. Entries will be calculated for a particular object class by the following equation:

(SF 225 Column (3) amount) X (NavCompt Form 225A Column (4) %) = SF 225 entry

Object class 12 will be footnoted for SFLI and FICA amounts to be calculated from the corresponding footnote of the NavCompt Form 225A.

d. Section II - Advances, Reimbursements, Other Income, etc. For unexpired accounts only, enter in column (3) amounts representing advances, reimbursements, or other income received and credited to the appropriation or fund. Also, net downward adjustments representing recoveries of prior obligations will be included in the amount to be reported on this line when such recoveries are required to be reported separately on the DD Form 1176. The entry for Section II must equal the sum of lines 3A, 3B and 4 of the DD Form 1176 for unexpired accounts.

e. Section III - Net Obligations Incurred. Enter in column (3) the result of Section I minus Section II.

f. Section IV - Expired Accounts (adjustment during reporting period). Enter in column (3) the net adjustments (either upward or downward) of prior year obligations for expired accounts (including the related successor accounts) which have been recorded during the current year to date. The entry for section IV must equal line 7 minus line 4 of the DD Form 1176 for all prior year accounts only.

g. Section V - Net Unpaid Obligations. Enter on this line, in column (3) only, the amount of net unpaid obligations as of the close of the reporting period. The entry for Sec. V must equal line 13 (total column) of the DD Form 1176, with the following exception:

(1) Navy general fund account affected by transfers to other government agencies e.g., 69-17X1205, will vary from the DD Form 1176 line 13, Net unpaid obligations by the amount of Net unpaid obligations of the receiving agency. The responsible offices will provide the data reported by the receiving agency for cumulative obligations and disbursements as a footnote to the Supplemental Schedule to the Report on Budget Execution (NavCompt Form 2232), for cumulative obligations line 7A.1, Obligations Transfer Account and cumulative disbursements line 14.1, Disbursement Transfer Account. The SF 225 will be footnoted by NCB-3 for the amount of Net unpaid obligations excluded from Section V for Net unpaid obligations of the receiving agency.

As appropriate, responsible offices will footnote NavCompt Form 2232 for the amount of Intrafund-Funded Unfilled Orders end of period included in Section V as 13B3.A, Unfilled Orders - Intrafund-Funded.

7. Supply of forms. Standard Form 225 is available from the Cog I segment of the Navy Supply System under ordering number 0109-201-0310 and is stocked at the Navy Yard, Washington, D.C. and the Naval Supply Centers, Norfolk and Oakland. NavCompt Form 225A may be reproduced locally from enclosure (1), as needed.

E. W. COOKE
DIRECTOR OF BUDGET AND REPORTS

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NavCompt Form No. 225A
Aug 1974

Period Ending: ______

PERCENTAGE REPORT ON OBLIGATIONS
(Estimate)
(In hundredths of percent)

AGENCY	Appropriation or Fund Title
BUREAU	Unexpired Accounts, Current Year Symbols

Description (1)	Object Class Symbol (2)	Transact, Fiscal Year to Date: Total Transactions (3)	Transact, Fiscal Year to Date: Within Federal Government Only (4)
Gross obligations by object class			
Personnel compensation	11		
Personnel benefits	12		
Benefits for former personnel	13		
Travel and transportation of persons	21		
Transportation of things	22		
Rent, communications, and utilities	23		
Printing and reproduction	24		
Other services	25		
Supplies and materials	26		
Equipment	31		
Lands and structures	32		
Investments and loans	33		
Grants, subsidies, and contributions	41		
Insurance claims and indemnities	42		
Interest and dividends	43		
Refunds	44		
Undistributed U.S. obligations	96		
Obligations incurred abroad	97		
Unvouchered	98		
TOTAL		100.00	

Enclosure (1)

Standard Form No. [illegible]
May 19[illegible]
TREASURY DEPARTMENT Fiscal Service
Department Circular No. 1012
[illegible]

[illegible]

Page _____ of _____
Period ended: _____

REPORT ON OBLIGATIONS

(IN THOUSANDS OF DOLLARS)

AGENCY	Appropriation or Fund Title
BUREAU	Unexpired Accounts, Current Year Symbols

Description (1)	Object Class Symbol (2)	Transactions, Fiscal Year to Date: Total Transactions (3)	Transactions, Fiscal Year to Date: Within Federal Government Only (4)
SECTION I—Gross obligations by object class			
Personnel compensation	11		
Personnel benefits	12		
Benefits for former personnel	13		
Travel and transportation of persons	21		
Transportation of things	22		
Rent, communications, and utilities	23		
Printing and reproduction	24		
Other services	25		
Supplies and materials	26		
Equipment	31		
Lands and structures	32		
Investments and loans	33		
Grants, subsidies, and contributions	41		
Insurance claims and indemnities	42		
Interest and dividends	43		
Refunds	44		
Undistributed U S obligations	96		
Obligations incurred abroad	97		
Unvouchered	98		
TOTAL SECTION I			
SECTION II—Advances, reimbursements, other income, etc.			
SECTION III—Net obligations incurred			
SECTION IV—Expired Accounts (adjustment during reporting period)			
SECTION V—Net unpaid obligations			

APPENDIX B

STATISTICAL ANALYSIS

To compare two sets of time series data, as was previously stated, one criterion which may be used is the comparability of the rates of increase over time. By fitting various equations to the data, one may then test statistically the equivalence of the rates of increase.

In this appendix, each of the mathematical models used to fit the data will be explained, along with the applicable tests of hypotheses. The resulting equations will then be presented along with the results of the hypothesis tests.

A. LINEAR MODELS

1. Simple Least Squares Linear Model

The model in this case is

$$I1_t = \alpha + \beta I2_t + e_t \quad .$$

This models one index as a linear function of the second. Simple linear regression may be used to estimate the parameters α and β, where α is the intercept of the line and β is the rate of increase of $I1_t$ with respect to $I2_t$. If the two indices are the same, one would expect that α would be zero while β would be one. If the two indices are not the same, then the intercept may differ from zero.

However, the rates of increase of the first index may still be the same as the second, in which case β should still equal one. The appropriate statistical test is then a T test with (n-2) degrees of freedom. The null hypothesis is that $\beta = 1$ which implies that the rate of increase of the first index is the same as the second over time, but the indices may differ in value, as reflected by the intercept, α.

2. <u>Simple Least Squares Linear Model Forced Through A Given Point</u>

The model in this case is

$$I1_t = \beta\, I2_t + e_t \; .$$

This equation also models one index as a linear function of the other. In this case, however, the line is forced through a given point. Since the indices are normalized to equal the value 100.0 at the beginning of the time period, this model may be used to force the line through the point (100,100). This is intuitively appealing. A modified least squares procedure may then be used to estimate the parameter β by coding the data such that the line is forced through the origin. The derivation of the formulae for the parameter and its variance is given below using the "Best Linear, Unbiased" method [Ref. 9]. The same estimator for β may be derived by the "Least Squares" method.

Since both indices were normalized, the coding was simply to subtract 100.0 from each index. This resulted in new constants, $I1_t^*$ and $I2_t^*$, from which β was estimated.

Under the condition that the intercept is zero, it may be shown that the estimators have all of the usual desirable properties; that is, β is a "linear, unbiased estimator," and has minimum variance.

Since the actual line which is estimated passes through the point (100,100), however, the problem of over-identification of the parameter β occurs [Ref. 9]. This results from the implicit intercept which is generated from the model. This problem is shown as follows: The model for which the parameter is to be estimated is

$$\text{a)} \quad I1_t^* = \beta\, I2_t^* + e_t$$

where

$$I1_t^* = (I1_t - 100)$$

and

$$\beta\, I2^* = \beta(I2_t - 100).$$

Therefore, the model actually estimated may be written

$$I1_t - 100 = -\beta\, 100 + \beta\, I2_t + e_t$$

or

$$\text{b)}\quad I1_t = 100(1-\beta) + \beta\, I2_t + e_t \; .$$

This equation has the usual least squares form:

$$I1_t = \alpha + \gamma\, I2_t + e_t$$

where

$$\alpha = 100(1-\beta) \qquad \text{or} \qquad \beta = 1 - \frac{\alpha}{100} \; ,$$

and

$$\gamma = \beta \qquad \text{or} \qquad \beta = \gamma .$$

Thus there is no unique solution for β if the usual linear model is used to estimate it. Therefore equation a) must be estimated directly.

The implications of this model are that, if $I1_t$ is the same as $I2_t$, then the intercept for model b) is zero, and the slope, β, is one. Therefore, the applicable hypothesis test is a T test with (n-1) degrees of freedom. The null hypothesis is that $\hat{\beta} = 1$.

a. Derivation of the "Best Linear, Unbiased Estimator, $\hat{\beta}$, and its Variance.

In order for $\hat{\beta}$ to be a best linear, unbiased estimator, it must be a linear combination of the sample

observations, must be unbiased, and its variance must be smaller than that of any other linear, unbiased estimator. Therefore,

$$\hat{\beta} = \sum_t a_t \cdot I1_t ,$$

where a_t are some constants to be determined.

$$E[\hat{\beta}] = \hat{\beta}\left(\sum_t a_t \cdot I2_t \right)$$

implies that $\sum_t a_t \, I2_t = 1$, for $\hat{\beta}$ to be unbiased.

$$\begin{aligned}
VAR[\hat{\beta}] &= VAR\left[\sum_t a_t I1_t \right]^2 \\
&= E\left[\sum_t a_t e_t \right]^2 \\
&= E\left[\sum_t (a_t e_t)^2 \right] + 2E\left[\sum_{t<s} (a_t e_t)(a_s e_s) \right] \\
&= E\left[\sum_t (a_t e_t)^2 \right] \\
&= \sigma^2 \sum a_t^2
\end{aligned}$$

by the assumptions of homoskedasiticty and nonautoregression, and where e is the random error.

The problem is now to:

$$\text{Minimize} \quad \sigma^2 \sum_t a_t^2$$

$$\text{Subject to} \quad \sum_t a_t \, I2_t = 1$$

Solution by the LaGrange method gives

$$\hat{\beta} = \frac{\sum_t I1_t \cdot I2_t}{\sum_t I2_t^2}$$

and $$\mathrm{VAR}[\hat{\beta}] = \frac{\sigma^2}{\sum_t I2_t^2}$$

Solution by the least squares method gives the same estimator formula. σ^2 is estimated by the maximum likelihood method and is estimated by

$$\hat{\sigma}^2 = \frac{\sum_t (I1_t - \hat{\beta}\, I2_t)}{t - 1} .$$

B. EXPONENTIAL MODELS

These models assume that the functional relationship between the index and time is linear in the logs. This allows for curvilinearity in the raw data, or that the rate of growth of the index over time is exponential.

1. Exponential Growth with Non-Zero Intercept in the Logs

In this case, the model is

$$I_t = \exp(\alpha + \beta \cdot T_t + e_t)$$

where T is ordinal time. That is, for this model, time begins at T = 0 . This model estimates as the percent rise in the index per increment of time. Mathematically, this may be written as

$$\beta = \frac{dI/I}{dT} \qquad \begin{array}{l} I \text{ for index} \\ \\ T \text{ for Time} \end{array}$$

The intercept, α, is estimated from the data. For T = 0, at the beginning of the time series, since the index is normalized to base 100, α should equal 4.605, the natural logarithm of 100. However, the rate of increase over time, β, is the important parameter. For comparison purposes, the hypothesis that the rates of increase over time of two indices are the same may be tested. The test statistic is T distributed with $(n-1)$ degrees of freedom [Ref. 2].

One of the assumptions made in linear regression is that $E(e_i e_j) = 0$ for all $i \neq j$. This is the assumption of non-autoregression. This implies that the random disturbance occurring at one point in time is not correlated with any other disturbance. This assumption is more often violated in the case of relations estimated from time series data than in the case of relations estimated from cross sectional data.

It may be shown that if the disturbances are autoregressive, then estimates of the variances of the least squares estimators are biased. Therefore, the conventional formulae for carrying out tests of hypotheses may lead to incorrect conclusions. It may further be shown that when rho, the correlation coefficient is positive, the bias in the variance of the estimator is negative. Thus, if the disturbances are autoregressive and rho is positive, the calculated acceptance region will often be narrower than they should be for the specified level of confidence.

Where this model was used, rho and the Durbin Watson statistic is presented for each equation, although the number of data points is low.

2. Exponential Growth with Intercept Through A Specified Point

This model is written as

$$I_t = 100 \exp(r\ T_t + e_t)$$

The rate of increase is again the percent rise in the index per increment of time. At T = 0, the index wil equal 100.

The rate of increase, r, may be estimated using the method described in Appendix B, A., 2. for the following equation:

$$Il^{*}_t = \text{Ln}\ (Il_t/100) = r\ T_t + e_t$$

Two indices may again be compared by testing the hypothesis that the rates of increase are the same. The test statistic is again T distributed, with (n-1) degrees of freedom.

C. RESULTS

The following tables present the results of the estimation of each of the mathematical models for each object class and the account as a whole.

The test statistics were compared against those given in Table B-1.

Table B-1

D.F.	F (α = .1)	T (α = .05)
09	3.18	2.262
10	2.98	2.228
11	2.82	2.201

TABLE B-2

EQUIPMENT

$n = 11$

1. $EQUIP_t = \alpha + \beta\ I2_t + e_t$

$$EQUIP_t = \underset{(1.9017)}{-11.2867} + \underset{(0.1593)}{1.1035}\ IMPD\ EQUIP_t + e_t$$

$R^2 = .99 \quad \sigma^2 = 0.7020 \quad T_9 = 0.649 \quad$ ACCEPT H_o

2. $EQUIP_t = I2_t + e_t$

$$EQUIP_t = -7.4193 + \underset{(0.0134)}{1.0742}\ IMPD\ EQUIP_t + e_t$$

$R^2 = .92 \quad \sigma^2 = 1.1636 \quad T_{10} = 5.52 \quad$ REJECT H_o

3. $I1_t = \exp(\alpha + \beta T_t + \varepsilon_t)$

$$EQUIP_t = \exp(\underset{(0.0270)}{4.5640} + \underset{(0.0046}{0.04145}T_t + \varepsilon_t)$$

$R^2 = .90 \quad \sigma^2 = 2.2946 \times 10^{-3} \quad \rho = .6767 \quad DW = .746$

$$IMPD\ EQUIP_t = \exp(\underset{(0.0225)}{4.5715} + \underset{(0.0038)}{0.0386}T_t + \varepsilon_t)$$

$R^2 = .92 \quad \sigma^2 = 1.5972 \times 10^{-3} \quad \rho = .6360 \quad DW = .796$

H_o: $\sigma_1^2 = \sigma_2^2 \quad F_{9,9} = 1.437 \quad$ ACCEPT

H_o: $\beta_1 = \beta_2 \quad T_{18} = 0.472 \quad$ ACCEPT

4. $II_t = 100 \exp(rT_t + \varepsilon_t)$

$EQUIP_t = 100 \exp(0.0356T_t + \varepsilon_t)$
(0.0026)

$R^2 = .88$ $\sigma^2 = 2.260 \times 10^{-3}$ $\rho = .9149$ DW = .634

$IMPD\ EQUIP_t = 100 \exp(0.0338T_t + \varepsilon_t)$
(0.0022)

$R^2 = .90$ $\sigma^2 = 1.792 \times 10^{-3}$ $\rho = .8856$ DW = .680

H_o: $\sigma_1^2 = \sigma_2^2$ $F_{10,10} = 1.449$ ACCEPT

H_o: $r_1 = r_2$ $T_{20} = 0.274$ ACCEPT

TABLE B-3

EQUIPMENT 1973-1975

$n = 12$

1. $EQUIP_t \;=\; \alpha + \beta \; IMPD\; EQUIP_t + e_t$

$EQUIP_t \;=\; -9.004 + 1.1040 \; IMPD\; EQUIP_t + e_t$

(0.0025)

$R^2 = .98 \qquad \sigma^2 = 3.7850 \qquad T_{10} = 2.080$ ACCEPT

2. $EQUIP_t \;=\; \beta \; IMPD\; EQUIP_t + e_t$

$EQUIP_t \;=\; -16.788 + 1.1679 \; IMPD\; EQUIP_t + e_t$

(0.0038)

$R^2 = .87 \qquad \sigma^2 = 4.8689 \qquad T_{11} = 4.447$ REJECT

3. $Il_t \;=\; \exp(\alpha + \beta T_t + \varepsilon_t)$

$EQUIP_t \;=\; \exp(4.559 + 0.0102 T_t + e_t)$

(0.0007)

$R^2 = .96 \qquad \sigma^2 = 7.495 \times 10^{-4}$

$IMPD\; EQUIP_t \;=\; \exp(4.554 + 0.0092 T_t + e_t)$

$R^2 = .94 \qquad \sigma^2 = 6.577 \times 10^{-4}$

$H_o: \; \sigma_1^2 = \sigma_2^2 \qquad F_{10,10} = 0.866$ ACCEPT

$H_o: \; \beta_1 = \beta_2 \qquad T_{20} = 1.556$ ACCEPT

4. $Il_t \;=\; 100 \exp(rT_t + e_t)$

$EQUIP_t \;=\; 100 \exp(0.0076 \; T_t + e_t)$

(0.0004)

$\sigma^2 = 9.612 \times 10^{-4}$

$$\text{IMPD EQUIP}_t = 100 \exp(0.0088T_t + e_t)$$

$$\sigma^2 = 1.142 \times 10^{-3}$$

H_o: $\sigma_1^2 = \sigma_2^2$ $F_{11,11} = 1.188$ ACCEPT

H_o: $r_1 = r_2$ $T_{22} = 1.895$ ACCEPT

TABLE B-4

UTILITIES WITH FREIGHT AND UTILITIES WITHOUT FREIGHT

$n = 36$

2. $UTIL(W/O)_t = \beta\ UTIL(W.F.)_t + e_t$

$UTIL(W/O)_t = 7.514 + 0.9249\ UTIL(W.F.)_t + e_t$

(0.0051)

$R^2 = .99 \quad \sigma^2 = 0.2378 \quad T_{70} = 14.78$ REJECT

3. $Il_t = \exp(\alpha + \beta T_t + e_t)$

$UTIL(W/O)_t = \exp(4.5735 + 0.0080T_t + e_t)$

(1.75×10^{-4})

$R^2 = .98 \quad \sigma^2 = 1.19 \times 10^{-4}$

$UTIL(W.F.)_t = \exp(4.5686 + 0.0087T_t + e_t)$

$R^2 = .98 \quad \sigma^2 = 1.56 \times 10^{-4}$

$H_o: \sigma_1^2 = \sigma_2^2 \quad F_{34,34} = 1.305$ ACCEPT

$H_c: \beta_1 = \beta_2 \quad T_{68} = 2.534$ REJECT

4. $Il_t = 100 \exp(rT_t + e_t)$

$UTIL(W.F.) = 100 \exp(0.0075T_t + e_t)$

(0.0002)

$R^2 = .96 \quad \sigma^2 = 3.59 \times 10^{-4}$

$UTIL(W/O) = 100 \exp(0.0070T_t + e_t)$

(0.0001)

$R^2 = .96 \quad \sigma^2 = 2.66 \times 10^{-4}$

$H_o: \sigma_1^2 = \sigma_2^2 \quad F_{35,35} = 1.35$ ACCEPT

$T_{70} = 2.426$ REJECT

TABLE B-6

UTILITIES

$n = 11$

1. $UTIL_t = \alpha + \beta I2_t + e_t$

$UTIL_t = 4.5823 + 0.9235\ PXP_t + e_t$

$(3.8606) \quad (0.0306)$

$R^2 = .99 \quad \sigma^2 = 4.2080 \quad T_9 = 0.2503$ ACCEPT

$UTIL_t = 18.2100 + 0.7767\ SERVICES_t + e_t$

$(5.1406) \quad (0.0387)$

$R^2 = .978 \quad \sigma^2 = 9.4162 \quad T_9 = 5.770$ REJECT

2. $UTIL_t = \alpha\ I2_t + e_t$

$UTIL_t = 15.0818 + 0.8492\ PXP_t + e_t$

(0.2664)

$R^2 = .98 \quad \sigma^2 = 7.9487 \quad T_{10} = 0.5661$ ACCEPT

$UTIL_t = 30.6820 + 0.6932\ SERVICES_t + e_t$

$R^2 = .96 \quad \sigma^2 = 1.553 \quad T_{10} = 10.05$ REJECT

3. $I1_t = \exp(\alpha + \beta\ T_t + e_t)$

$UTIL_t = \exp(4.5435 + 0.0460\ T_t + e_t)$

$(0.0235) \quad (0.0040)$

$R^2 = .94 \quad \sigma^2 = 1.74 \times 10^{-3} \quad \rho = .58 \quad DW = .64$

$PXP_t = \exp(4.5693 + 0.0488 T_t + e_t)$

$(0.0173) \quad (0.0029)$

$R^2 = .97 \quad \sigma^2 = 9.4 \times 10^{-4} \quad \rho = .72 \quad DW = .58$

$H_o: \sigma_1^2 = \sigma_2^2 \quad F_{9,9} = 1.853$ ACCEPT

$H_o: \beta_1 = \beta_2 \quad T_{20} = 0.56$ ACCEPT

$$SERVICES_t = \exp(4.5733 + 0.0566T_t + e_t)$$
$$(0.0106) \quad (0.0018)$$

$R^2 = .99$ $\quad \sigma^2 = 3.5 \times 10^{-4}$ $\quad \rho = .56$ $\quad DW = .58$

H_o: $\sigma_1^2 = \sigma_2^2$ $\quad F_{9,9} = 4.98$ $\quad$ REJECT

H_o: $\beta_1 = \beta_2$

4. $$Il_t = 100 \exp(\beta T_t + e_t)$$

$$UTIL_t = 100 \exp(0.0372 T_t + e_t)$$

$R^2 = .89$ $\quad \sigma^2 = .0028$ $\quad \rho = .95$ $\quad DW = .40$

$$PXP = 100 \exp(0.0436 T_t + e_t)$$
$$(0.0018)$$

$R^2 = .95$ $\quad \sigma^2 = .0012$ $\quad \rho = .99$ $\quad DW = .43$

H_o: $\sigma_1^2 = \sigma_2^2$ $\quad F_{10,10} = 2.209$ $\quad$ ACCEPT

H_o: $\beta_1 = \beta_2$ $\quad T_{20} = 1.99$ $\quad$ ACCEPT

$$SERVICES = 100 \exp(0.0521 T_t + e_t)$$
$$(0.0013)$$

$R^2 = .98$ $\quad \sigma^2 = 0.000634$ $\quad \rho = .96$ $\quad DW = .32$

TABLE B-7

OTHER SERVICES

$n = 11$

1. $O.S._t = \alpha + \beta\ I2_t + e_t$

$O.S._t = -48.1460 + 1.4465\ PXP_t + e_t$

$R^2 = 9.0607 \quad \sigma^2 = 19.279 \quad T_9 = 6.82$ REJECT

$O.S._t = 9.0607 + 0.8983\ STRUCTURES_t + e_t$

$(6.3567) \quad (0.0451)$

$R^2 = .98 \quad \sigma^2 = 23.679 \quad T_9 = 2.25$ ACCEPT

2. $O.S._t = \beta\ I2_t + e_t$

$O.S._t = -36.1726 + 1.3617\ PXP_t + e_t$

(0.0408)

$R^2 = .98 \quad \sigma^2 = 22.763 \quad T_{10} = 8.02$ REJECT

$O.S._t = 11.8653 + 0.8813\ STRUCTURES_t + e_t$

(0.0286)

$R^2 = .98 \quad \sigma^2 = 21.901 \quad T_{10} = 4.147$ REJECT

3. $I1_t = \exp(\alpha + \beta\ T_t + e_t)$

$O.S._t = \exp(4.5397 + 0.0644\ T_t + e_t)$

$(0.0304) \quad (0.0051)$

$R^2 = .94 \quad \sigma^2 = 0.0029 \quad \rho = .45 \quad DW = .88$

$PXP = \exp(4.5693 + 0.0488\ T_t + e_t)$

(0.0173)

$R^2 = .97 \quad \sigma^2 = 0.0009$

$H_o: \sigma_1^{\,2} = \sigma_2^{\,2} \quad F_{9,9} = 3.094 \quad$ ACCEPT

$H_o: \beta_1 = \beta_2 \quad T_{18} = 3.72 \quad$ REJECT

$$\text{STRUCTURES}_t = \exp(\underset{(0.0255)}{4.5426} + \underset{(0.0043)}{0.0703}\, T_t + e_t)$$

$R^2 = .97 \quad \sigma^2 = .0020 \quad \rho = .67 \quad DW = .54$

$H_o: \sigma_1^{\,2} = \sigma_2^{\,2} \quad F_{9,9} = 1.42 \quad$ ACCEPT

$H_o: \beta_1 = \beta_2 \quad T_{18} = 0.89 \quad$ ACCEPT

4. $$Il_t = 100 \exp(\beta\, T_t + e_t)$$

$$\text{O.S.}_t = 100 \exp(\underset{(0.0032)}{0.0550}\, T_t + e_t)$$

$R^2 = .92 \quad \sigma^2 = 0.0040 \quad \rho = .92 \quad DW = .63$

$$PXP_t = 100 \exp(\underset{(0.0018)}{0.0436}\, T_t + e_t)$$

$R^2 = .95 \quad \sigma^2 = .0012$

$H_o: \sigma_1^{\,2} = \sigma_2^{\,2} \quad F_{10,10} = 3.17 \quad$ REJECT

$H_o: \beta_1 = \beta_2$

$$\text{STRUCTURES}_t = 100 \exp(\underset{(0.0028)}{0.0614}\, T_t + e_t)$$

$R^2 = .94 \quad \sigma^2 = 0.0031 \quad \rho = .97 \quad DW = .36$

$H_o: \sigma_1^{\,2} = \sigma_2^{\,2} \quad F_{10,10} = 1.29 \quad$ ACCEPT

$H_o: \beta_1 = \beta_2 \quad T_{20} = 0.107 \quad$ ACCEPT

TABLE B-8

SUPPLIES AND MATERIALS

$n = 11$

1. $S\&M_t = \alpha + \beta\ I2_t + e_t$

$S\&M_t = -114.2787 + 1.9710\ PXP_t + e_t$

$(35.5636) \quad (0.2816)$

$R^2 = .84 \quad \sigma^2 = 357.09 \quad T_9 = 3.45$ REJECT

$S\&M_t = 9.4617 + 0.8865\ CPIFUEL_t + e_t$

$(2.1058) \quad (0.0144)$

$R^2 = .99 \quad \sigma^2 = 5.467 \quad T_9 = 2.056$ ACCEPT

2. $S\&M_t = I2_t + e_t$

$S\&M_t = -55.4822 + 1.5548\ PXP_t + e_t$

(0.2009)

$R^2 = .78 \quad \sigma^2 = 451.88 \quad T_{10} = 2.66$ REJECT

$S\&M_t = 13.2132 + 0.08675\ CPI\ FUEL_t + e_t$

(0.0133)

$R^2 = .99 \quad \sigma^2 = 7.380 \quad T_{10} = 9.95$ REJECT

3. $I1_t = \exp(\alpha + \beta\ T_t + e_t)$

$S\&M_t = \exp(4.4600 + 0.0739\ T_t + e_t)$

$(0.0933) \quad (0.0158)$

$R^2 = .71 \quad \sigma^2 = 0.0274 \quad \rho = .71 \quad DW = .60$

$PXP_t = \exp(4.5693 + 0.0488\ T_t + e_t)$

$(0.0173) \quad (0.0029)$

$R^2 = .97 \quad \sigma^2 = 0.0094$

H_o: $\sigma_1^2 = \sigma_2^2$ $F_{10,10} = 29.11$ **REJECT**

CPI $FUEL_t = \exp(4.4[illegible]32 + 0.0822\ T_t + e_t)$

(0.0912) (0.0155)

$R^2 = .76$ $\sigma^2 = 0.0262$ $\rho = .64$ $DW = .69$

H_o: $\sigma_1^2 = \sigma_2^2$ $F_{9,9} = 1.047$ **ACCEPT**

H_o: $\beta_1 = \beta_2$ $T_{18} = 0.379$ **ACCEPT**

4. $Il_t = 100 \exp(\beta\ T_t + e_t)$

$S\&M_t = 100 \exp(0.0540\ T_t + e_t)$

(0.0089)

$R^2 = .64$ $\sigma^2 = 0.031$ $\rho = 0.84$ $DW = .51$

$PXP_t = 100 \exp(0.0436\ T_t + e_t)$

(0.0018)

$R^2 = .95$ $\sigma^2 = 0.0012$

H_o: $\sigma_1^2 = \sigma_2^2$ $F_{10,10} = 24.56$ **REJECT**

CPI $FUEL_t = 100 \exp(0.0620\ T_t + e_t)$

(0.0088)

$R^2 = .69$ $\sigma^2 = 0.0299$ $\rho = .80$ $DW = .568$

H_o: $\sigma_1^2 = \sigma_2^2$ $F_{10,10} = 1.03$ **ACCEPT**

H_o: $\beta_1 = \beta_2$ $T_{20} = 0.63$ **ACCEPT**

TABLE B-9

O & M,N

$n = 11$

1. $O\&M,N_t = \alpha + \beta\ I2_t + e_t$

$O\&M,N_t = -60.0000 + 1.5283\ CBO_t + e_t$
$(11.9292) \quad (0.0944)$

$R^2 = .97 \quad \sigma^2 = 40.2764 \quad T_9 = 5.60$ REJECT

$O\&M,N_t = 7.7900 + 0.9015\ PROXY_t + e_t$
$(4.5308 \quad (0.0322)$

$R^2 = .99 \quad \sigma^2 = 13.7929 \quad T_9 = 3.06$ REJECT

2. $O\&M,N_t = I_2 + e_t$

$O\&M,N_t = -35.4879 + 1.3549\ CBO_t + e_t$
(0.0725)

$R^2 = .95 \quad \sigma^2 = 58.9852 \quad T_{10} = 4.90$ REJECT

$O\&M,N_t = 12.8136 + 0.8719\ PROXY_t + e_t$
(0.0230)

$R^2 = .99 \quad \sigma^2 = 14.65208 \quad T_{10} = 5.57$ REJECT

3. $I1_t = \exp(\alpha + \beta\ T_t + e_t$

$O\&M,N_t = \exp(4.5192 + 0.0654\ T_t + e_t)$
$(0.0442) \quad (0.0078)$

$R^2 = .89 \quad \sigma^2 = 0.0062 \quad \rho = .78 \quad DW = .54$

$CBO_t = \exp(4.5692 + 0.0488\ T_t + e_t)$
$(0.0174) \quad (0.0029)$

$R^2 = .97 \quad \sigma^2 = 0.0009 \quad \rho = .72 \quad DW = .58$

$H_o: \sigma_1^2 = \sigma_2^2$ REJECT

$$PROXY_t = \exp(4.5262 + 0.0718\ T_t + e_t)$$
$$(0.0396) \quad (0.0067)$$

$R^2 = .93 \quad \sigma^2 = 0.0049 \quad \rho = .68 \quad DW = .59$

$H_o: \sigma_1^2 = \sigma_2^2 \quad F_{9,9} = 1.25$ ACCEPT

$H_o: \beta_1 = \beta_2 \quad T_{18} = .628$ ACCEPT

4. $I1_t = 100 \exp(\beta\ T_t + e_t)$

$$O\&M,N_t = 100 \exp(0.0532\ T_t + e_t)$$
$$(0.0045)$$

$R^2 = .85 \quad \sigma^2 = 0.0079 \quad \rho = 1.03 \quad DW = .42$

$$CBO_t = 100 \exp(0.0437\ T_t + e_t)$$

$R^2 = .95 \quad \sigma^2 = 0.0012 \quad \rho = .99 \quad DW = .43$

$H_o: \sigma_1^2 = \sigma_2^2 \quad F_{10,10} = 6.24$ REJECT

$$PROXY_t = 100 \exp(0.0605\ T_t + e_t)$$
$$(0.0041)$$

$R^2 = .90 \quad \sigma^2 = 0.0064 \quad \rho = .91 \quad DW = .44$

$H_o: \sigma_1^2 = \sigma_2^2 \quad F_{10,10} = 1.23$ ACCEPT

$H_o: \beta_1 = \beta_2 \quad T_{20} = 1.20$ ACCEPT

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